PROBLEM
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DEDICATION.

All bodies are moved by the same force, proportioned to the mass to be moved, whether it be an atom, a man, a globe, or a solar system. This was my cradle in childhood, and now it is my car in the winter of age. I have ridden it alone, and so far as my professional opinions, with professional men, are compared (with few exceptions), I have had a companionless pilgrimage in life. But with generous patrons, doubting yet believing, they have cheered me on my pathway, and now at its close I dedicate the fruits of my labor to them.

ADDRESS TO THE READER.

MAN is the problem for solution, and the force which moves all things, proportioned to the mass to be moved, must be demonstrated to find him.

By his forces, we mean man as he moves, acts, feels, and thinks, with all his joys and sorrows, with all his doubts and difficulties, and all his apprehensions of a coming future.

He will be found low in the scale of being, next to his atom; and if the atom is understood, the man is easily comprehended. The demonstration of the motive power of the universe is subsidiary to the atom—this, the atom, is the grand achievement which unfolds the relations of the universe by its own momentum.

Some hints to trace it, may teach the reader how to find it. If he supposes the atom to be 1, and he goes on in the usual style of calculation, that 1 plus 1 = 2, he at once encounters the astounding truth that there is no exact science, to which this process (if true) must inevitably lead him, and he is in the direct tract to perdition—the falling sin of the centripetal law—the tract in which the anatomist, the physiologist, the physician, the math-

ematician, the optician, the chemist, the *Judge, with his justice,** and especially the astronomer, have fallen, yet rising with their fractions, out of which they make new propositions to correct aberrations, and the aberrations never end.

They are all alike working from a circumference, which they have not traversed, toward a centre which they will never find. If the atom be 1, the problem has been studied long enough to prove that 1 plus 1 is not 2, and that two ones are two ones still, and either of the ones is a compound. What is a compound ?—pause and think. A compound has parts, and parts are degrees of deviation from the standard—1 is the standard, and its degrees being deviations from its centre, it is the centre of the circumference of its relations, and the centre is centrifugal—the demonstration of this atom being centrifugal, works from the centre toward the circumference, with no fractions for propositions, to correct aberrations.

The first great example of this centrifugal force, was displayed by the first Napoleon, who fought centrifugally, and with a handful of men sent centripetal armies to destruction.

The second was the late Daniel Webster, who thought centrifugally, and sent, in the gulf-stream of his thought, the side currents backward to fall within his trail.

* Law runs out before it comes to equity, and chancery is set up to correct its aberrations.

PREFACE.

All bodies are attracted directly as the mass, and inversely as the square of the distance. This is the Law of Sir Isaac Newton, and what service has it been to man except to darken science by its council.

It sent him, first, in search of the ultimate atom of matter, when the initial atom would have given the ultimate with undeviating certainty. It then gave him Dalton's definite proportions in matter *fixed*, when on inquiry, they are found to be changing relations with equivalents.

These *fixed* proportions are the basis of science, and if the basis falls, the fixed proportions fall with it, and must inevitably change the relations of every science with which it is connected, and throw the current of human thought into a centrifugal channel.

The examination of this centripetal law, leads to the disclosure that it is the discovery of only one half of a fact, founded in the returning force of a motive power, while the laws of Archimedes, Galileo, and Laplace are each discoveries of a whole fact, and each approach a law in proportion to the spaces which they respectively occupy.

There is one class of men who knew no law, to whom this centripetal law has been a God-send. Mechanics

have gained many fortunes in the form of patent rights because they were at variance with this centripetal law.

But it has been any thing but a God-send to human life. Here is the central cemetery of the Law, and Sir Isaac is the monument which represents the mute testimony of those who fill the silent tumuli of ages that have gone by. If medical men have made mistakes, they are backed by high authority. Sir Isaac Newton is their standing referee, and decides every blunder in their favor by his law. Every force in organic life is demonstrated centripetally. The process of breathing the air is regarded as the source of life, having its circumference in the outward world, and its centre in the lungs ; and the circulation of the blood has its attractive force in the capillary system.

But when we go back to the foundation of the nervous system, I dislike to speak of it lest my remarks may be thought to be invidious, but the least I can say of it is to liken it to a skein of tangled yarn, full of knots, with their angles demonstrated backward.

If the mischief stopped with the yarn it would not involve human life ; but every scientific work which treats of human life, is based on this centripetal demonstration of the nervous system ; and every work thus written (and they are all thus written) must be read backward, to be understood by the reader. If medical men will consent to give up Sir Isaac Newton's centripetal law, medical science will stand on an eminence deserving its name, but if they accept the protection of this law in their practice, they receive no reproach from my pen. The starting point of this work is defined in the condensed

form of its proposition, viz. : That all bodies are repelled directly as the mass, and inversely as the square of the distance, and it stands in direct opposition to that of Sir Isaac Newton, that all bodies attract each other directly as the mass and inversely as the square of the distance.

It is obvious that one or the other of these propositions must be wholly false, not only in their parts but as a whole. If my proposition be wrong, its first step is wrong, and like a watch set wrong, must run wrong to the end, and *vice versa*.

To my mind it is clear that Sir Isaac Newton's law has demonstrated all right things into wrong centres, and what we have thus far gained in *real science*, has been the triumph of genius in common sense over the distorted sciences of the day.

Having repudiated the laws of Archimedes, Galileo, Newton, and Laplace (as laws), I feel relieved, and am happier with no law, than with ideal laws which misled me, acknowledging my obligations to Dalton for his nearer approximation to a law than all of his predecessors, and regret for his memory that his law, too, must share the fate of all things which are passing away.

My general proposition, as stated in the work, is this—that all bodies in nature are moved by the same force proportioned to the mass to be moved, whether it be an atom, a man, a globe, or a solar system. This proposition, with its broad basis, betokens no anarchy or confusion in the rule of its action on the subjects of its power, and yet with this fair promise the book opens on squinting eyes looking at it, as an unacknowledged foundling exiled from science, and every one who reads it must regard it as an out-law

opposed to his education and the current of his daily thoughts.

The following points hitherto unknown or conjectural, will most of them be found demonstrated: Specific gravity,—attraction,—repulsion,—water an electro-magnet,—its decomposition by its own agency,—the electro-motive force of the universe,—the earth an electro-magnet,—the atom centrifugal. Atom does not unite with atom; it throws out braces in angles which unite with each other in centres of circumference—their rotation.

All forces are binary—laws of Archimedes, Galileo, Newton, and Laplace, only facts; law of universal causation—development. Dalton's definite proportions are changing relations—growth of matter—spontaneous organization—infusoria—muscular force—standard of power in man $\frac{8}{100}$ of force to $\frac{2}{100}$ of material. New demonstration of the nervous, medullary, and cerebral systems of relation with the electro-magnet of human life.

Man, like the earth, is an electro-magnet, with his axis only an inch and a quarter long, while that of the earth is one-third of its length.

So little time has been given to the writing of this work, that the subject matter must take the responsibility of the crudity of its form till a new edition is prepared.

VITAL FORCES.

BY WHAT MOTIVE POWER ARE THEY DRIVEN?

In our professional pursuit, we have abandoned the remains on the dissecting table in search of the motive power which once animated and moved the fragments we left there. The principle of life necessitates the element of motion, and yet in their reciprocal action no light is shed on their changing relations. In the investigation of life per se, or of motion per se, there is found no beginning, no middle, no end, and we have taken a backward step for a motive power, in pursuit of both, to ask the direct question, what is the proximate cause of motion?

Motion, instead of being considered a secondary cause, has hitherto been confounded with the will of God, and this belief is still maintained, partly from the mystery which spreads its veil over the cause of motion, but chiefly from the proposition laid down by Sir Isaac Newton, "that all bodies persevere in their present state, whether of rest or motion, unless disturbed by some foreign power."

This proposition has not been proved, and yet by the overshadowing authority of his great name, it is believed, and has finally resulted in the conviction that motion is not an essential attribute of matter. In this we agree, that it is not an essential attribute *of* matter. The elements of matter are properties held in common with all forms of organic life, and presuppose a force which made them together with all material bodies in nature. Force gives to matter its form, and the forming law being the sustaining power of all things, makes motion an essential element *in* matter. We risk nothing in these speculations. We are abroad in the field, an apprentice philosopher, gleaning what we can from the labyrinth of science to bring home the fragments to our laboratory of life, and without stating any formal proposition to foreshadow our opinions, we frame this for our motto: Sit atomus, sit homo, sit orbis, sit systema solare, omnia materialia in natura moventur vi eadem æquabili moli movendæ.—"All material bodies in nature are moved by the same force proportioned to the mass to be moved, whether it be an atom, a man, a globe, or a solar system." If it be found that the atom, the man, the globe, and the solar system, are each made in centres of circumference by one law, and the sum of attraction, in the circumference of each group of relations, be equal to

the sum of repulsion in the centre, then all are governed by a centrifugal law with mutual relations and dependencies. Creation was the first result of power, and man the focal centre of its exercise. Power may be said to be the product of the universe multiplied by its radial forces into itself, and thus adjusted, it moves onward toward one common centre, every atom of which bears a certain and fixed relation to its antecedent atom, in the formation, disintegration, and reproduction of the whole. Delegated for the great purposes for which it was made, it stands in immediate relation to its great First Cause, from which we withhold all speculation. All power is first passive, in its repose it is not cognizable to our senses, we perceive it only when it rises into force. Power and force are to be distinguished from each other by their mutual relations and dependencies. There is but one power given whose radial forces fill the universe. Power is force at rest, force is power in action. The elements of the storm are found in its calm. We are unconscious of the ocean of air in which we live, as it passively surrounds us, and rises above us toward that heaven of which it is the most familiar synonym and symbol; the hum of the feeblest insect may be heard in its whispers, and the tiniest forms may wave it aside with their wings, and yet if we insulate the electricity in a

cubic foot of its measure, (when set free,) the crash of its thunderbolt is a motive power of terrific intensity.

Man feels his power to act bfore he exerts it, and his power to judge before he executes it; hence power is the prior relation of force. Where then shall we begin our inquest? If we contemplate the phenomena of motion, as Sir Isaac Newton did, on the boundless scale of the universe, we have the means to observe its phenomena, but not to investigate its cause; all our ideas of it being adjusted to a scale beyond our immediate comprehension. To understand the cause of motion we must bring it into contact with our senses, and survey the examples which surround us on every side, on the earth, in the earth, in the heavens, and in the winds. If we begin our inquest with the first motion on record, we must begin with the first thing that was made, and that was space; but space is supposed to be an imaginary ether, and agents that cannot be detected either by their own weight, or by chemical union with other bodies, are incompatible with known laws.

If we take the atmosphere whose atoms have not rested since the dawn of creation, and whose gaseous forms in alternate mutations are shifting from pole to pole, refreshing every degree of latitude with its ever varying degrees of temperature; we are familiar

with the facts, but unacquainted with its law. If we take man, the focal centre of all motive power, and the special object of our investigation, and the model we intend to work by, and whose motive force we have set ourselves to prove; it is his complex relations which we are aiming to unfold, by discussing the motive power antecedent to his formation.

If we take the earth, this great electro-magnet, that wheels around its gorgeous circuit with no betrayal of its rate of motion, we stand observers of the fact, and array ourselves against the current of public opinion when we deny that it moves by the attraction of gravitation.

But as we cannot conceive of matter apart from the space it occupies, and as space holds the prior relation, we are forced, in searching for causation, to give to space the first consideration, and when it gains the position and importance to which it is entitled, by the Creator's first endowment, instead of a vacuum that pre-exists with its extension of continuity to continuities,* it will turn out to have density, and its molecules to hold prehensile relations to the bodies which move in it. If space holds no relation to matter where would its extension end? If space

* Prof. Pierce's Smithsonian Lectures.

be extension, and extension not a force, the matter which floats in space could be held by no law. But if space be extension, and extension a force which is made by the molecules of matter that float in it, then it must be governed by the law of changing relations with equivalents, and the matter which floats in space is governed by its rule.

Space holds priority to matter, and under the present centripetal law matter is set down "to be essentially inert," and covers no more space than it occupies.

In the displacement of this law by a centrifugal power, matter occupies more space than it covers, and it occupies it, not by the force of attraction, but by its own central energies.

Examples:—Let two blocks of wood of equal magnitude be placed in contact on the surface of smooth water, and they will repel each other—make them of unequal magnitudes, and place them apart on the surface of smooth water, and they will attract each other into contact. The spaces which these blocks respectively occupied in the first experiment, when they repelled each other, was the square of the cube of each block, and these spaces are made and maintained by the repellant power in each block to make room enough for itself to move in, and the experiment shows that matter

holds within its molecules a force which makes and covers more space than it occupies.

To illustrate this force more clearly and set its relations fully before the mind, let us take the definite proportions in the combinations of matter as our rule, $\frac{1}{2}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, and so onward, and let the cell, which is the beginning structure of all material bodies in nature, (both organic and inorganic,) be the example. Let the specific gravity of this cell be 1, and the space it occupies be $1\frac{1}{2}$, what relation will the square of 1 hold to the cube of the space it occupies? $1\frac{22}{3}$ or 1–3 and $\frac{3}{3}$ to 1; that is, the atom by its repellant power makes its own space in which to move in the proportion of 3 and $\frac{3}{6}$ to 1, and if we take the next higher combination in matter, 2–$2\frac{1}{2}$, space extends in arithmetical progression.

When space is considered "a vacuum which pre-exists with extension of continuity to continuities," it merely represents a vacuum in the mind of its author. But when space is regarded as extension, and extension a force, and both are contemporaneous with matter, and all are made at the same time, and by the same power, and worked by the same force, and governed by the same law, it opens to our vision the mutual relations and dependencies of the universe, and unfolds the prevision of Him who

abhorring a vacuum, ordained that space should be plenum.*

Oxygen, whose proportion is greater than that of all other substances in nature, and whose specific gravity exceeds that of all other bodies in the proportion of 48 to 21, ballooned by its attendant gases fills immensity with its power, and animates the scene in space far beyond our telescopic vision. If space be plenum, with degrees of deviation in the density of its molecules that are incessantly changing their relations, and the forces in these molecules make their own spaces to move in, by the same law the earth on which we are moving with such insensible and inconceivable velocity, may be regarded as a molecule of higher order, and maintained in space as all other bodies are maintained, not by attraction but by its rate of motion.† Bodies moved by attraction must be moved in the mass, and not on their centre, and their spaces must be in the direct line of attraction only, and not interchangeable. The physical discoveries of Prof. Faraday are in unison with this centrifugal force we are aiming to unfold. He has shown that all bodies which are not magnetic, with the exception of the gases, range

* The attenuation of the gases in space is bounded by the opposition offered to its expansion by the pressure of other matter.

† A cannon ball maintains itself in space so long as its primitive rate of motion is kept up. See proof in the gyrascope.

themselves east and west when freely suspended over the poles of a magnet, (whether natural or artificial,) instead of north and south, which gives the proof of a duplicate arrangement for rotary power and centrifugal force.

These experiments show too, that needles, rolls of sulphur, resin, feathers, glass, phosphorus, gold, silver, lead, bismuth, place themselves equatorially from the centre across the line connecting the poles of a horse-shoe bar of iron at the moment the bar was converted into a magnet by electro-agency. It was these experiments which led him to distribute all material substances in nature into two great classes; *one of which is repelled by the poles of the magnet, so that they are placed by this force equatorially to the line of the poles, while the remaining class being attracted by the poles of the magnet, arrange themselves axially and centrifugally in the line of the poles.*

These axially arranged bodies are magnetic; the equatorially, dia-magnetics.

The bodies which he finds to be magnetic are iron, nickel, cobalt, manganum, chromium, cerium, titanium, paladium, crown-glass, platina, osmium, and *oxygen*. The dia-magnetics are the remaining solids, and that focal centre of all motive power, water, when in its decomposition by the Voltaic battery, it

evolves the power of ozone, while bismuth takes the foremost place among the metals. It is manifest from the physical arrangement of the electro-magnetic forces, the one axial, and the other equatorial, that the earth moves on its centre, with a twofold (rifle) motion, the one on its plane and the other on its axis, and it is our design to show that this dual motion, the one axial, and the other equatorial, rises from one definite cause which gives the planet its directive momentum in space, not by attraction, but by the force of its own central energies. The power which acts on the axial and equatorial arrangements of matter is a motive power, and impels the mass by rotating the atoms which compose the mass; the motion of the whole being the sum of the motion of all its parts.

As space is prior to matter, the atoms must have space to move in, and when these spaces (cells) among the molecules of matter in the interior constitution of the globe, are considered in their relations and bearings, to the molecules which move around them as their common centre, then matter will take the secondary place assigned to it (that of balancing forces) in the mechanism of the universe.

The spaces or cells among the molecules of mat-

ter, will be found to be the repositories of power, and the molecules are charged with its forces.

As atoms are the constituent molecules of the physical world, and make up the substance of all material bodies, they must have a community of origin, a community of end, aim, purpose, and destination, and our inquest into their nature and properties will testify to their agencies in the motive power of the universe; and this brings us into the consideration of

INORGANIC HISTOLOGY

All inorganic bodies, like those of organic life, take their forms from their cells, and these cells of inorganic matter bear the same relation to the granular matter of material bodies, that the cells of organic life bear to the tissues that spring their walls. The vitalized cells that begin the structure of animal life have no nerves traceable in their organization, and hence their power is passive (it is force at rest); but the nerves, the most highly vitalized organs of human life that spring from their walls are active, and go to form the delicately equipoised structure of human life. They are the electro-magnets of the vital force, the transmitting, but not the motive power. Such, too, is the relation which the cells of inorganic bodies hold to the

granular matter of their organization. The microscope discloses the fact, that these cells hold the passive or dialectric power which propagates the molecules of matter around their common centre.

This cell with its cell force, is the starting point of motion in all bodies; and the microscope, which magnifies the atoms of matter four millions of times beyond their normal size, magnifies the cells in the same ratio; and it is now clearly ascertained by this instrument that the atoms of matter which compose the most solid bodies of the universe, are not in contact, but are held apart and maintained apart by a power in these cells which is not attraction—that under Nasmyth's hammer the cells among the atoms of iron or steel may be lessened, but no force whatever can close the pores which nature has interposed between the granular molecules of matter. Nor can the utmost force of the hydraulic press change the globular form or close the cells among the drops of water that constitute the volume within its grasp. These cells hold the repellant power, and when the press is raised, the reaction of the volume of water will give the square of the distance of each drop of water from the other, and measure the size of the cell.

The cell is now known to be the germinating nucleus of all material bodies in nature; and the

microscope has disclosed the rotation of every atom of matter around its cell, as a necessary condition of its relation to its centre. In this rotary process of the atoms around their cells, it is always found to be preceded by axial deflections among the atoms of matter, and the return of polarized atoms to their normal state, and in the successive alterations of these polarized relations, the transmission is maintained with such inconceivable rapidity, that the eye beholds only a moving panorama in a dissolving view of these changing relations. It is but a vibratile motion of the axis of material atoms, establishing the same atomic movements from opposite directions, all the molecules being so arranged that their indwelling polarities adjust their relations to each other, and to the order of their successive developments, being quickened or retarded by the varying speed or exalted temperature of the moving mass. The friction of bodies upon each other has long been known to exert a positive force in alternate directions, but it has been reserved for electrical science, aided by the microscope, to disclose the rotary motion among the atoms of matter around their cells as their common centre. It was the experiments of Berzelius that first led him to conceive that two opposite poles were given to every atom of matter, and M. De Larive, following his

footsteps, first observed that every rotary atom thus armed had a directive axis around which the movement was performed. But it must be apparent now to every mind, that if the electro-magnetic force, or any other force in nature is held to be opposite momenta, science must come to its stand; but, if we exchange the terms opposite momenta for opposite relations, with their mutual dependencies, that science, released from this dogma, will march onward in infinite progression.

In this view of opposite relations repulsion takes its place as the central force in matter, and the immediate cause of rotary action, while attraction is the returning, restraining and adjusting force.

Electro-magnetism having taken the place of repulsion and attraction, would bear this definition:— Electro the dynamic power, and magnetism its returning force.

There is a series of experiments in electro-magnetism which *prove* positive electricity to possess a greater repellant force than negative electricity at the same tension, and that the positive pole holds the dynamic force, while the magnetic action arrives at the point of departure at the same instant of time, leaving every thing behind it adjusted, as before.

It is now shown, in the experiments as well as in the axial and equatorial arrangements of the

molecules of matter by Prof. Faraday, that the earth is physically arranged to move both on its plane and on its axis, by a motive power.

The proof that electro is the dynamic power, and magnetism the returning force, would seem to justify the opinion that electro-magnetism is a motive power, and this leads us to a deeper question, viz. :—

WHAT IS ELECTRO-MAGNETISM?

The dual term electro-magnetism signifies a dual relation with mutual dependencies, and the element of these relations finds its foundation in oxygen gas, with its equivalent ozone.

The experiment of introducing the gases into soap bubbles, has proved oxygen to be highly *magnetic*, while its attendant gases are neutral, showing its presiding power over the destinies of matter, by its standing the proximate cause of electro-magnetism.

The next step to the discovery that electro-magnetism has its foundation in the gases, unfolds another proof no less important. M. Manignac and M. De Larive have both shown that oxygen, the great element of chemical energy (motive power), has another relation, and is readily turned into

ozone, and that ozone is *oxygen* in a highly concentrated state of chemical power, and that any quantity of pure oxygen may be turned into ozone by electrical agency alone. In all explosions which take place by the decomposition of water, the sulphurous odor of ozone is present. When water is undergoing decomposition by the voltaic circuit ozone is developed, and it pervades the atmosphere when lightning is flashing.

The discovery that oxygen and no other gas is magnetic—that it is convertible into ozone, and that ozone is a changing relation and alternate force of highly concentrated chemical power, brings us a step nearer to the primitive elements of power and force in these relations. In their active state they develop electricity, and electricity in its turn of changing relations with equivalents disaggregates the molecules of these gases, and in the process insulates their constituent atoms with all their polarities set free, by which they acquire a concentrated tendency to combine their relations *with all other bodies in nature toward which they manifest no affinity in their normal state*, and hence the universal and unlimited command of these gases over the motion of all material bodies. In this dual relation of the first elements of matter we see the working principle of its power, viz.—that electro-magnetism,

in disaggregating the molecules of oxygen gas, reproduces itself in the process of disintegration, fully setting before us the phenomena of motion among the molecules of matter with its cause yet undisclosed.

We have now reached a standpoint that enables us to say that neither heat nor electricity can be considered motive powers. They both pass through bodies disturbing and exciting these molecules, and leave them as before in a condition of repose. They are carrying forces, not powers. In telegraphy we see the development of electro-magnetism at the termini of the wires at remote distances.

If it was a motive power it would not transmit the force but propel the wire, and hence it is the common carrier of a power behind it. The mechanical power that moves matter is wanting in electro-magnetism, and is next to be sought for in the element which causes electro-agency in all bodies.

OXYGEN.

Having shown that magnetism is a property of oxygen—that it is an agent and not a cause, a force and not a power, our next step leads to the examination of oxygen itself. Its chemical energies are

well understood. Nihil dictum quod non dictum est. It is proved to be magnetic—it is known to be the principle of life, and now we are to show it to be the element of motion. And first its specific gravity. Before other substances were made its relative proportion to its attendant gases stood thus: to hydrogen $\frac{16}{1}$, to nitrogen $\frac{16}{14}$, to carbon $\frac{16}{6}$, showing its proportion to be greater than that of all other substances in nature, and its specific gravity to exceed that of all other bodies in the proportion of 48 to 21. As these gases are the constituent elements or bases of matter, they constitute the specific gravity of all substances which are made by their atomic combinations, and hence they are the measure and sum of the specific gravity of all bodies in the universe; *e. g.:* when oxygen and hydrogen unite to form water, the specific gravity of the water (which is the standard of all adjustments) is the sum of the specific gravity of these gases condensed into its volume, and hence the specific gravity of oxygen in the weight of the globe must stand as 48 to 21.

Now with its density and its abounding weight it has the property of permanent elasticity.

Elasticity and *permanent elasticity* is the difference between a finite and an infinite force.

Caoutchouc is an elastic force permanently at

rest, while oxygen gas is an elastic force permanently in motion, and as its relative proportion is greater than that of all other substances in nature, it is a force fitted to the mechanism of the universe, with power to move and maintain its ponderous machinery in perpetual motion.

The law of motion in all elastic bodies is exactly equal in opposite directions, and they retain the motion which they receive from their elastic power. This affirmation is in accordance with the proposition of Sir Isaac Newton, "that the quantity of motion which is collected by taking the sum of the motions directed toward the same parts, and the difference of those directed to contrary parts, suffer no change from the action of bodies among themselves." Force thus constituted, and thus adjusted, acts in direct unison with the alternate motions among the molecules of matter disclosed by the microscope, and by proportioning its force to the matter it moves, it rotates an atom or commands a world.

Secondly. Its prior relations to its attendant gases, and its mechanico-vital principle show it, as it is set forth to be, the original element or first thing that was made, and in its decomposing and recomposing energies it proves itself to be the secondary cause of all things with the germ of their inevitable dissolution.

The finite mind without any knowledge of its own construction instinctively copies from its own model, and each pattern it throws off brings it nearer and nearer to a first cause, and hence it is always working on the principle of induction—oxygen came from the infinite Mind in the form of a triune relation, $\frac{16}{1}$, $\frac{16}{14}$, $\frac{16}{6}$, and so far as we have observed in the physical world it gives only dual relations, on which is founded the law of changing relations with equivalents—withholding one relation which we know not of.

Thirdly. By introducing it into soap bubbles, it has been proved to be magnetic. Now by measuring its power with its attendant gases it will show it to be the cause of attraction.

The component parts of all matter are the gases of oxygen, hydrogen, carbon and nitrogen, of which oxygen forms so distinguished a part. In order to explain the force of its attraction, we must measure the force of the mutual relations of oxygen with its attendant gases, and this will show which of them holds the sovereign power over the movements of matter. The relative force in which these gases stand to each other will determine their several powers. Oxygen to hydrogen $\frac{16}{1}$, to nitrogen $\frac{16}{14}$, to carbon $\frac{16}{6}$; that is, oxygen is fifteen times heavier

than hydrogen, nearly three times heavier than carbon, and as sixteen is to fourteen heavier than nitrogen, oxygen being the heaviest of the gases. To measure the force of their mutual attraction, we must measure the velocity with which they approach each other. The velocity with which all bodies approach each other by mutual attraction is inversely as the quantity or masses of matter. Thus the velocity with which the lighter body gravitates toward the heavier is greater than that with which the heavier moves toward the lighter. In the mutual attraction of the gases then, oxygen stands the greatest attracting force.

Now when we come to consider the great disproportion of hydrogen, carbon and nitrogen to oxygen in the masses of matter, the amount of attraction can only be measured by the amount of oxygen in all nature.

It was this overwhelming proof that misled Sir Isaac Newton to the error that attraction was the primitive element in matter, and that it was the forming and sustaining law of the universe. But induction carries us a step backward to the inducing question which might have been as appropriately asked in his day as in our own, whether attraction was not a derived force held in obedience to some antecedent power? The directive tendency

of this force to bring all masses of matter to a point of rest, would seem to have urged upon the mind of man the early necessity of searching for some other cause of motion, or at least of doubting its truth. If the spaces among the molecules of matter had been then known, they would have been, as they are now, unappreciated. But it was then known that, when the atoms of matter came to be situated near each other, their action became positive, and changed from attractive to repulsive, and these alternate transitions from one state to another repeatedly occurred within very narrow limits. Still nearer the centre the power exerted was invariably repulsive, augmenting in proportion to proximity, else the spaces among the molecules would be forced together, and matter must permanently collapse.

If this statement be true, it follows that all masses of matter, without regard to size, from the atom to the globe we occupy, have their centres invariably repulsive, while their repulsive or centrifugal force is equipoised by the mighty force of attraction which binds each atom to the next in order, and holds the whole universe together.

Every atom of matter in the universe must consist of a certain force of differing intensities in different directions, which repel particles directly as

the mass, and inversely as the square of the distance. By this law we see the same force proportioned to the mass to be moved makes a tear, or dew-drop, or a world, and having reached the law which makes a world, we turn from the spectacle of its beauty and its grandeur, to contemplate the force of its inevitable dissolution.

Oxygen is the supporter of all combustion* and all disintegration, and yet is itself incombustible; properties which seem to confer on it the power of Omnipotence, always giving without loss, for ever supplying without diminution, and thus it presides over the formation, maintenance, and dissolution of all bodies in nature.

Our general postulate may now be taken, that repulsion and attraction are compounds of each other, namely, of oxygen and ozone, and are co-existent and co-equal forces, with this difference, that attraction is the weaker power, and can only be maintained by an accumulation of material by which all bodies grow; that when any body or substance in nature can accumulate no more material, the attractive force must begin to give way, and the motive

* Lord Brougham in his memorial of Sir Isaac Newton, says the substance having most eminently the properties of an acid (chlorine) is found to have no oxygen at all. If the water of chlorine be not composed of oxygen, what is it?

power will cause its dissolution by the disintegration of its atoms.

Let Sir Isaac Newton's apple, by which he demonstrated the attraction of gravitation, be the example. The minie apple is attracted to the stem by a force so strong that its attachment to the tree will be broken in any attempt to separate it, while the ripening process is going on, but when fully ripe it can receive no more material, and the force which nourished it being its repelling power, attraction gives way and it is thrown from its parent stem, and dissolved by the force which formed, sustained, and nourished it into life. Every substance in nature is full of this testimony; not only the products of earth, but the globe itself is an example of this truth. It is known that all vegetable life, the grass which clothes the earth with its spring and summer growth, the flower that adorns it, the shrubs which beautify it, the trees and forests exalted above the rest, catching the first rays of the dawning light, and bowing their graceful arches to the setting sun, gather four-fifths of their substance from the air they breathe.

All these, with the exception of the evergreens, circulate water, and when the frosts of autumn come, the water being the conductor of heat and life, conducts both to the air from which it was derived,

and the motive or repelling power dissolves the mass, and adds the product of this annual decomposition to the growth of the earth; and when this globe has reached its condition of repose by perfect combination, and can accumulate no more material (a condition that no substance in nature can bear), it will reach it at the moment when the central sun, with all its attendant planets, which revolve around it, complete their structure, and the clock of time, that has so long kept its records, will run down, and the transient night will be followed by the morning of the resurrection.

Having shown repulsion to be the central force of all bodies, and attraction its co-equal at the same tension, while the tension is maintained by an accumulation of material, we have reached the final question, What is the motive power, and how is it developed and maintained?

Thus far forces have been discussed by their popular names of electro-magnetism, dia-magnetics, repulsion and attraction, names which gave the phenomenal action of forces and furnished no clue to their causation. It has been shown that oxygen is in greater proportion than that of all other substances in nature—that it is the element of all specific gravity—that it is mechanico-vital—that its permanently elastic motion is of differing intensities

in different directions—that it is the magnetic returning and restraining force, and ozone its alternate relation. If this be admitted and these relations be true, it necessitates ozone (the alternate relation) to be the motive power, and oxygen its returning force, and both are generated in the decomposition of water by electro-agency.

No natural force, electrical or otherwise, can take place apart from the agency of water. The action of the dry voltaic pile is entirely due to the presence of water in the paper used for the con struction of the pile, and frictional machines at a moderate rate of motion generate ozone, by taking the moisture from the surrounding air.

The voltaic piles and batteries used for telegraphic purposes, derive their forces from the decomposition and recomposition of the waters within the cells of the battery by electro-agency.

It is known that a very small amount of chemical change sets free a very large electrical force. Both Becquerel and Prof. Faraday have shown that larvate electricity (ozone) chemically set free by the decomposition of one grain of water, will charge a thunder cloud covering an area of thirty-five acres, the explosion of which would produce a flash of lightning of terrific intensity.

But insular forces, generated by the decomposi-

tion of water, are shown on a broader scale in earthquakes. Months before the paroxysmal explosions of Vesuvius begin, the low murmurings of its ordinary discontent are heard rising from the ingathering force, generated by the conversion of water into ozone at the bottom of the crater. As the deep sounds like distant thunder multiply, the waters around the base of the mountain disappear, and the wells dry up. The inhabitants in nearest proximity to the mountain confer with each other, and measure their danger by the area of country dried up, in the waste of water by the crater.

Pompeii is three miles from the base of this mountain, and streams and wells have been known to dry up five miles beyond its outward boundary, which gives a circumference of forty-eight miles, within which the waters are taken up and converted into ozone, in gradual preparation for the explosion that follows.

It is the scarcity of water that gives to volcanic mountains situated on dry land, long periods of repose. Stromboli, three thousand feet high, is situated in the Mediterranean, surrounded with its waters, thirty miles from shore, and its supply of water being always the same, it is seen puffing night and day with undeviating uniformity. Water at the maximum of its expansibility loses its mechani-

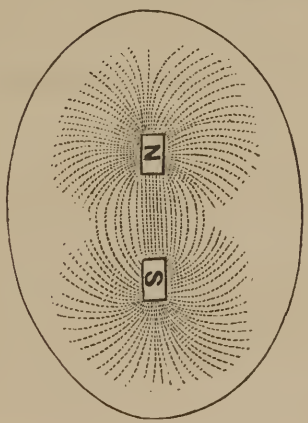
cal force, and at this point it is converted into ozone and an explosion follows. But it has been shown by Prof. Faraday, that electricity in a continuous current, when set free by the decomposition of a grain of water, will maintain a platinum wire placed in it, red-hot for three-and-a-half minutes; and on the other hand, if the same measure of electricity by the decomposition of a grain of water be insulated, its explosion in a thunder-cloud will cover an area of thirty-five acres with a terrific flash of lightning. The difference in these resulting forces, arising from the same motive power, measures the difference between the force of an electrical discharge and an electrical current. It is the decomposition of water by its own agency in the electrical current which gives uniformity to the motive power of the universe, and enables it to work up to its time-table with undeviating certainty.

EARTH.

The physical arrangements of this great electro-magnet into axial and equatorial relations, discovered by the ingenious researches of Prof. Faraday, may now be considered in connection with the force which gave to the earth its form and its motion from the beginning.

The magnet is the suggesting instrument which

has guided our researches to our present state of knowledge, and the electrical currents which it marks out in its diagram indicate the true electrical currents maintained by the decomposition of water in the interior constitution of the globe. When black lead is showered down on the surface of a glass plate, or over a sheet of white paper, and held perpendicularly over the magnet, the atoms of lead are seen to acquire the polarity of the magnet itself, which instantly repels the particles from each other, and throws them into curves of unequal variation outward toward the circumference. These curves proceed from foci at their termini, and advancing from cell to cell increase in diameter with the distance from the terminus, as exhibited in this cut.



The central magnet has its axial forces running

north and south, with its axis set, not obliquely, but horizonal to its orbit.*

The line drawn around the circle of this cut gives the ellipticity of the earth,† and the first glance at its electrical forces diverging from the central magnet toward the circumference, gives the differing intensities of its different directions in operation both ways. This formula for the foundation and superstructure of the earth is made by nature's magnet, which gives the model for every planet of a twofold motion that rotates on its axis and moves on its plane.

To destroy this proof and restore attraction to the position it has occupied among all material bodies, the magnet must be made to reverse this process, and draw the atoms from the circumference toward the centre of the glass plate, and then magneto-electricity will take the place of electro-magnetism, and attraction will hold unlimited command over the motions of matter, and the cells among the molecules of granular structures will be drawn to-

* Sir Isaac Newton, whose system of the universe rests partly upon contingent truth, draws all the axes of his planets obliquely to their orbits, that they may conform to his theory of attraction, forgetting their positions on a plane of ascending elevation, that their axes there must revolve perpendicularly to their orbits.

† Sir Isaac Newton states that the rates of the centrifugal force to gravitation determines the ellipticity.

gether, and all bodies assuming one uniform standard of specific gravity, will fall from their ellipses into some bottomless pit that has hitherto escaped the scrutiny of science.

The learned Dr. Boynton is now lecturing to full houses in the city of New York, propagating the theory that "our planet was once a melted mass of rock, and melted because of the heat generated by the chemical union and action of the particles of which it is composed. As the surface of the melted mass cooled a crust was formed, and this constituted the granite rock. By the cooling and contracting of this crust a pressure was exerted on the melted interior, causing the upheavel of mountains and bursting forth of volcanoes."

As the forming law is the sustaining power of all things, the antecedent of this rock suggests the question, How was it made before it was melted, and how maintained in space while the melting process was going on? A melting mass has no axial or equatorial arrangements, no electrical currents, no water that has not passed the maximum of its expansibility and become explosive.

Water was the first binary compound that announced the beginning of the physical world, "when darkness was still on the face of the deep." Of its mighty agency among the atoms of matter,

we know less than is yet concealed from us, but we know that it is the *constituent element* of all the minerals or masses of matter that make up the body of the globe; that all the natural waters of the earth are proved by analysis to hold in solution some or all of the mineral bodies that constitute the structure of vegetable and animal life. Holding these mineral bodies in solution, the law of its changing relations deposits them, with inconceivable velocity, within the body of this aqueous globe till the dry land appears. Eight-ninths of the weight of water is oxygen, which gives the element of life to all its combinations, and its permanent elasticity gives the element of motion to all its changing relations. It is this elasticity which gives tides to the ocean and impulse to its mountain waves, while its electrical currents make its motive power by the decomposition and re-composition of its own molecules, establishing a rotary force of reciprocal production, which is mutually and permanently convertible into each other's relations—that is, one force generating and bringing together, in the same series of relations, physical forces which seem to be remote and dissimilar (see p. 16); e. g., the electrical current from a Voltaic battery, by the decomposition of water, produces every variety of chemical change, in accordance with the nature of the mate-

rial placed in its current, whatsoever its nature may be, whether solid, fluid, or gaseous, the rule of its action is the mutual substitution of forces among the atoms of matter submitted to its power.

Rising from one power, its forces are of differing intensities, and all proportioned to the mass to be moved, (gravitation included,) which answers the grave question submitted by Sir Isaac Newton to his readers, whether the agent producing gravitation was material or not. The specific gravity of all material bodies in nature being found in the condensation of the gases from which they are made, determines this question—a familiar example of which is known to all school boys—that when the two gases of oxygen and hydrogen unite together in the proportion of eight parts of oxygen to one of hydrogen, they instantly condense into water; and it is equally known, to all who live in northern latitudes, that at the temperature of 32° Fahrenheit water begins to crystallize, and condenses into ice. In this process we see two material bodies, water and ice, in differing degrees of condensation, moulding into form from gaseous elements not cognisable to our senses in their natural state.

Both water and ice are subject to the same law

of decomposition and recomposition that govern all other forms of matter, while the mutual substitution of their relations immediately derived from the gases is the foundation of all specific gravity in which the whole physical world has its origin and support.

The order of succession in which events occur, give us true history—the order of succession in which things are made, lead us back to causation. The four gases of oxygen, hydrogen, carbon, and nitrogen, are the primal elements of matter, and hold, in their changing relations, the crucial problem of science—not that they enter into combination with all forms of matter by the most complex affinities and relations; but as has been shown, they are the constituent elements of matter, and give to matter all its forms, forces, and vitality. It is yet true, that two of these gases, hydrogen and nitrogen, are accepted by science as simple elements, and the crucial experiment has not yet been performed which is to prove them to be compounds.

While Chemistry is adding to the perplexity concerning simple bodies, by multiplying instead of abridging their numbers, electricity, the most powerful, as well as the most delicate instrument of analysis, is gradually approaching the solution of the question, that there are no simple bodies in

nature. Electrical currents act upon all bodies, whatsoever their nature may be, whether solid, fluid, or gaseous ;* and a primary current which is supposed to be simple, is found to be compound by developing two induced secondary currents, and each secondary current develops two tertiary currents, and each tertiary current determines two quaternary currents.

It is observed that the secondary current assumes a primary form as it develops the tertiary current, and the tertiary current in its turn takes on a primary form as it determines the quaternary current. But if we suppose the primary current to be a simple force, we shall be puzzled to understand how it can give what it does not possess, viz., two secondary currents. But it is idle to suppose a simple substance to have existence. Isolated from all affinities, it could enter into no combinations, and having no germinating power, nothing to give and nothing to take, it must ever remain unchanged and eternal—with no companion in its solitude, it must stand alone a purposeless phenomenon, an unacknowledged foundling exiled from its share in the mechanism of the universe.

But it is the higher developments of the electrical current which more immediately impels our

* Faraday.

pursuit, when it evolves both heat and light, makes magnets, and, above all, when acting on the waters of the muscular tissues of organic life, it produces the most violent muscular force in its fibres that its structure can bear.

In this process is observed the same action and reaction in living structures that is disclosed by the microscope in inorganic matter, exhibiting the same law in its ascending scale of elevation working out the higher problems of human life.

As the mutual substitution of forces approximate to a law of action, it becomes necessary to define what we mean by law.

There are no three letters in the alphabet, excepting G-o-d, so full of meaning as L-a-w, and when they are spoiled by the addition of the plural s, they both alike lose their dignity and come into confusion. There is but one God, and he has made but one law, and that law is based upon changing relations with equivalents which meets every emergency of the physical world. Sir William Blackstone defines Law to be a rule of action; as well might he deny to God Deity, and say He is a rule of action. Law is a principle holding in its element not schemes, but a scheme of government, and its rule of action proceeds from within itself by an inherent necessity. The special acts rising out of

the necessity of a general law comprehends all acts not at variance with its general principle, and there is no emergency that these special acts will not reach. One special act may comprehend the whole Christian system of relations, and another special act rising from the same necessity may comprehend the system of civil government; but these acts are not in themselves laws; they are mere evolving necessities of the radial forces of the general law.

What we term laws of nature, are simply general facts discovered by distinguished men, made ardent for the purpose of solving difficult problems. The law of specific gravity, discovered by Archimedes, consists of only two facts, 1st. When a solid body is plunged into water, it displaces an amount of water equal in bulk to its own bulk; 2d. The solid body so immersed in the water loses in its weight an amount exactly equal to the weight of the liquid which it has displaced.

Galileo's law:—The less force equals the greater, by moving through more space in the same time.* On this fact Sir Isaac Newton based another fact: that all bodies attract each other directly as the mass, and inversely as the squares of the distance; then follow in succession the experiments and dis-

* If a rifle ball passes through more space in the same time than a cannon ball, why does it stop short of the latter?

coveries of Archimedes, Galileo, and Newton,—that in a mass of liquid each particle presses equally in all directions. If this were literally true, all lakes, seas, and oceans, apart from winds, would be as motionless and fixed as the rock upon its mountain bed. Then come the three laws of Kepler:—1st. The orbits of the planets are ellipses, with the sun in one of the foci; 2d. The planets move over equal areas in equal times; 3d. The squares of the times of revolution of any two planets are to each other in the same proportion as the cubes of their mean distances from the sun. This last discovery is conceived to be the most gigantic achievement of the human mind. But all these discoveries are *general facts*, which have been tried by the best method on the best evidence which the nature of the case admits, and have been confirmed by observation, and reduced to a science; but neither one nor all together have reached the dignity of a Law.

The nearest approach to the law of causation was reached by Dalton, when he found that all elementary bodies combine with each other to form compound bodies in definite proportions. This discovery made chemistry a science, as far as it goes; but electricity, by resolving all material bodies into forces, has shown that all forms of matter hold universal relations, and are compounds of each

other; and it is well known that all forms of numbers hold universal relations, and are compounds of each other, and being equal, the definite proportions in matter are demonstrated by these numbers under a given rule which governs the whole series consecutively.

One atom of A may unite with 1, 2, 3, 4 or 5 atoms of B, or 1 atom of A may unite with $\frac{1}{2}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$ or 4 atoms of B; and this combining proportion of all bodies in nature that unite with each other, are represented by these numbers, the numbers themselves being spoken of as the combining proportions *or equivalents* of the substances they represent. Numbers then stand in the same relation to each other as the combining proportions or equivalents in matter, and hence the problem of any one number; take, for example, the number 2, simple as it first appears to be, presents combinations so general as to be coextensive with all nature. It is at first difficult for the mind to conceive the illimitable range of any single number, or that parts of the number 2 form an aggregate of the remotest calculations in Algebra. Whatever is made up of parts, is made up of parts of those parts. As we trace the relations of number 2 with 1 and 3, we see it obeying the same rule as the combining proportions in matter: it has neither beginning, middle, nor end.

If we put down the numbers 1, 2, and 3 in this their order of relation, the number 2 is shown to be a compound of 1 and 3, decreasing in its deviations from number 3 toward number 1, and increasing in its degrees toward the number 3, so that its range is illimitable in both directions, as the subdivisions of number 1 can never be reached, and the accumulations of number 3 never exhausted. It has no mathematical point, no centre, no sides, no beginning, no end. Its parts are degrees, and its degrees are deviations from the standard, as well as from each other; the degrees themselves being the difference, the difference is always changing, and it loses its identity in its relations with 1 and 3. Thus the force of numbers lessen by subdivision in one direction, and accumulate in another without end, constituting a force, of substituting relations of differing intensities in different directions exactly parallel with the law of causation, or rather identical with it, as every change in numbers, whether by increase or diminution, brings out a new combination without end.

But the subdivision in one direction with its cumulative force, gives only the records of the past, while the accumulation of these changing relations in the future unfolds its creative and reproductive force to be forever reducing to its own sys-

tem all the relations and dependencies of mind and matter with the expression of acts in its general formula, that furnishes its plan or evidence of design to accomplish in a series of ages the general good of the whole.

A law which has from the beginning made no two things alike, and never stopped to make a duplicate, and has thus introduced into our system new facts, and by persisting combinations will form new series of facts in the unbroken order of their substitution of relations, and changing phenomena throughout all time, while its force increases in power in proportion to the number of combinations that enter into the masses, whether it be an atom, a man, a globe, or a solar system.

It is observed that the force thus constructed, works by the law of substitution of forces with equivalents on a strictly mathematical basis, so that numbers, and proportions of numbers, and geometrical figures, will express the relations of succession with a rigorous certainty that no change of circumstance can defeat, till all things it has created have reached their condition of repose by perfect combination, (a condition which no substance in nature can bear,) when the central energies of every system of relations will dissolve the masses, and bring them into new combinations without loss of material.

Having demonstrated the law of Causation, we come to its rule of action in Development.

Dr. Bushnell repudiates the connection of science with religion, and rejects the theory of development as a violation of both. It is idle to deprecate these relations; the connection exists, whether we recognize it or not. What would Dr. Bushnell's religion be without his science?

The ultimate idea of the material world leads directly to the immaterial, and we seem to be unconscious that we are perpetually applying to the phenomena of mind, conceptions which are primarily derived from those of matter.

It was these relations underlying these truths, which produced Butler's Analogy and Course of Nature. It is only when nature is partially understood, and revelation erroneously interpreted, that religion and science are placed in antagonism. The theory of development has shared its degeneracy with its ill-omened birth in the vestiges of creation, where the facts of science were at variance with the interpretation of its theory.

If we admit that God works by science instead of volition, the science will prove the rule of development with undeviating testimony. The law we have just been demonstrating, never stops with one series of relations to begin a new one;

there is no stop, no gap, no leap, no chasm in its progressive force; it makes no two things alike, nor deigns to stop to make duplicates, and its special acts embrace all the differing systems of relation in the universe. Every class of relations under its rule begins its structure with definite proportions of elements which never vary in the differing groups—if a single variation were possible in the groups it would explode the universe. The definite proportions of mineral, vegetable, and animal forms, when multiplied into each other, make every variety of forms of matter, and of animate existence, but cannot transcend the order.

The proposition of Paracelsus that "all living beings are composed of the elements of common matter, and are subject to the same law," comprehends within its grasp the structure of the whole physical world, and implies a rule of law. This law is before the reader, and I will follow its rule so far in the physical construction of matter, as to exhibit the phenomena of development, as the combinations in matter multiply in the ascending scale of being.

If I can demonstrate the popular notions entertained on the subject of development by such distinguished men as the late Hugh Miller and the present Dr. Bushnell to be in error, I shall have gained something, and if I can place them in their true light I shall achieve more.

Given: Paracelsus' opinion, that all living bodies are made out of the elements of common matter, then the relative proportions of these elements that enter into the composition of any body or substance in nature, will give its physical state.

First: all living bodies are composed of the elements of common matter. The plants on which animals feed, contain not merely the elements of their bodies, but their very substance; so that the scriptural declaration that "all flesh is grass," admits of the most literal chemical interpretation.

Grass, potatoes, starch, wheat flour, milk, rice, blood, fat, muscular fibre, fibrous tissue, nerves and brain, are the same bodies, with their particles differently arranged by combination; all that is primitive in one, is found in another. Now, in order to understand the structure of the physical world, (for I am to say nothing here of the spiritual properties of matter,) I say, in order to understand the structure of the physical world, and all that moves upon its surface, and to know how any thing or every thing is made, it is necessary to bear in mind, that the materials are all given; the analysis of all bodies, from the sand on the sea-shore, up to man, the monarch of matter, show of what materials they are made, and that there is an original perfect democratic equality in all the elements that enter into

all bodies, whatsoever they may be—the difference in bodies consisting only in the numerical proportion of the elements which enter into their beginning structure; that is, the number of elements which begin the structure of any body, or any substance in nature, determines what that substance or body shall be. This is a plain and intelligible proposition, and gives a broad and simple platform, on which to begin the inquest into the structure of the physical world; and the master-key to this proposition is the recognition of the presence of undeviating law in the combinations of matter, by definite proportions, and that invariability of sequence is the acknowledged basis of physical science, the uniformity of which can alone give value to experience, and render evidence in its true sense possible. A correct generalization under the guidance of law gives significance to the smallest detail, just as the great inductions in Geology demonstrate in every pebble, the working of a rule by which the earth has become adapted to the habitations of man.

Under the operation of this rule, all forms of matter, being made of the same elements, are necessary compounds of each other, and slide so imperceptibly into each other by relations so invisible, yet so demonstrable, that it has hitherto been found to be impossible to determine where one begins and

another ends—that between mineral, vegetable, and animal combinations, there is no determinate line of distinction in their beginning structure, but by an admissible and yet differing definition of definite proportions than has yet been given. Dalton's discovery of definite proportions, by which the atoms of matter unite with each other to make any given substance, is the greatest achievement of the human mind.

The planets would have observed the same course in their orbits, the central sun, conservative in their approaches to him, would still have sent them the genial rays of his light and heat; the stars, so remote that most of them are strangers, and the old familiar moon, faithful under disappointments, striving, with its feeble light, to keep the night in readiness for the coming day, all would have behaved in the same orderly manner, if Sir Isaac Newton had not been born. But in the discovery of definite proportions in matter, Dalton laid the foundation of chemistry, which has altered the fortunes of the human race, and yet for the want of a clear definition of definite proportions, it has curtained the profoundest mystery in creation, by concealing the process of development. Definite proportions are analytic distinctions, which threw their Lethean opiate into the mind as *fixed proportions*, and the

world of mind slept on, dreaming that the foundations in matter were fixed, and they were moving not with it, but on it. Definite proportions in matter defines limitation of its atoms, and stops them at some given point.

The arrest of one atom would be the signal for a general suspension of the whole mass, and what is termed nature, would fail. But analytic distinctions are lost in coexisting relations, and if definite proportions are substituted for definite relations, nature resumes her course in universal harmony of action. Definite proportions defined as definite relations, are binary compounds, with their degrees of deviation from each other; the degrees themselves being the difference, the difference is always changing, and they drop into the current of changing relations with equivalents, which is a just rule of action in all its parts, and one which Omniscient foresight devised for a self-sustaining power. In order to a more clear understanding of binary compounds, which make up the structure of the physical world, we return to the inquest of the binary number 2. This figure standing separate and apart from its fellows, clearly represents itself as being made of two ones; and the mind would be taken by surprise if the statement were denied. But if it were true, it would

reverse the whole order of nature, and reduce every atom of matter in the universe from binary forms into simple bodies, acknowledging no relations, and with no powers of reproduction, and no element of decay; the world would remain a purposeless ruin of Divine workmanship. But place the number 2 in the order of its relations, and it is shown to be a compound of 1 and 3, and like all other binary compounds, it represents not itself, but the relations out of which it has come.

Suppose, for illustration, a tear was standing in the eye or trickling down the cheek of a friend. It represents one thing to the eye and another to the understanding. It has not suggested itself as a binary compound of oxygen and hydrogen, but stands there the trembling emblem of sorrow, the representative of grief, anxiety, and care, and the tear is lost in the expression of its relations.

If definite proportions were true, we should have exact sciences, and find squares with all their angles exactly adjusted, and circles with all their radii exactly equal. But the equality of all the radii of a circle is true of all circles, so far as it is true of any one, but it is not exactly true of any circle; it is only so nearly true that we correct our conclusions by combining with them a fresh set of propositions relating to the aberration. So with the

number 2; it stands alone in its visible form, maintained, as the tear, by its invisible relations; and when traced in its relations to 1 and 3, it obeys the same rule as the combining proportions in matter. It has neither beginning nor end, as it decreases by degrees toward the number 1, and increases by the same degrees toward the number 3; it can have no mathematical point, no centre, no sides, no beginning, no end. A specific example of this may be quoted in human life, in a father, child, and mother. The child is a binary compound of father and mother, having no beginning, no middle, no end, and it stands as the representative of the relations out of which it has come,—relations so illimitable that we can trace them to no origin, nor comprehend their end. All numbers are reduced to a democratic level; no matter how remotely placed from each other, they all have the same value, and like the child of its parents, binary compounds, and all have the same share in the footing up of accounts. Every number has the same position between its relations; 3 is a binary compound of 2 and 4,—4 a binary compound of 3 and 5,—5 of 4 and 6,—6 of 5 and 7,—7 of 6 and 8, and so onward, the same as the seventh child would be a binary compound of the sixth and the eighth child, and all binary compounds of the same parents.

One example of mineral bodies is as good as a thousand; any three minerals which stand to each other in the same order as the numbers 1, 2, and 3, the elements of all being the same, they are like numbers compounds of each other, and although obviously distinct, the proportions are in definite relations. A higher example may be mentioned where a vegetable substance grows out of a mineral body, they also are binary compounds, with the same invisible relations in definite proportions, so that all matter, whatsoever its form or specific gravity, has unbroken and progressive relations.

Having shown the mysterious complexity in the combinations of matter to be not definite proportions but definite relations, we are enabled by its means to explain one of the most interesting questions in natural science, that has hitherto puzzled naturalists by its very simplicity; and this is what is called standard types in the order of creation, which rise one from the other in definite relations on the ascending scale of being. Some affirm that one type rising progressively from another type, takes from Omniscience his special intervention, and withdraws his superintending care from the objects of his creation. But it is obvious enough that each successive genera and species must be an improvement upon the preceding, because the law of reproduction

and decay is progressive, and the object of each change of type is to attain higher developments, and to advance a degree further toward a higher combination in a linear series from the simplest to the most refined and complicated organization. That this rule is not blindly followed, is apparent; for while the elements of all structures are the same, there is presented to us in the regular order of successive development every possible combination of organs, as if it had been the object to exhaust all the admissible permutations in the order of their succession.

That this order has a real foundation in nature is further proved by the steps in gradation, by which one type passes into another; and where chasms appear, species are always found to occupy intermediate places between adjacent types, and become links of connection in the great chain of being. But the infallible argument for the unbroken connection of types, to the naturalist, is found in the development of structures belonging to any particular type being always prospective, that is, incomplete in the inferior order of the group, formed upon the same model. For example, there are rudimental feet within the bodies of various serpents, which can obviously be of no service as organs of locomotion. These always remain more or less im-

perfect, although each organ fully answers the purpose of the individual being. Here science seems to have given all the facts of development in the ascending scale of being, and multiplied the difficulties by withholding the explanation. We naturally inquire, if definite relations so rigidly exact, determine a particular mineral or plant, larvæ or insect, or animal, or man, whence comes this interminable variety of minerals, plants, grasses, flowers, insects, animals, and human species. Naturalists who are in the habit of tracing the infinitesimal relations of all substances to each other as they rise from lower to higher states out of the same elements of matter, have been unable to account for the distinctions which exist. It was this difficulty which led the author of the Vestiges of Creation to maintain that one substance generated the next in order from lower to higher states, till the monkey came to be the progenitor of man. But it must be manifest to all minds, if the elements which constitute any compound body are given, and we can determine how many times they are multiplied into each other, and in what ratio the measure of the matter is given with its force and power. If it be a fucoid, the first born vegetable life, the binary elements which constitute it are three: 1, 2, and 3, can be multiplied into each

other indefinitely; there is no end to the combinations of these numbers, and none to the variety of groups in the vegetable kingdom. In the higher forms of animal life the binary elements which begin it are four.

For example, the Port Jackson shark is supposed to represent the sole surviving species of the oldest vertebrate family in creation, a family, so far as yet known by the entire geologic scale, icthyic existence first began. The mouth in this ancient family has undergone its changes by combination; instead of opening as in the shark of our day, under the middle of the head, it is terminal, and opens at the extremity of the muzzle much like that of the swine.

Suppose, for example, that the definite relations of binary compounds which constitute the beginning structure of this fish be 4 and 1–16th of one binary element, 3 of another, 2 of another, and 1 of another, no matter how indefinitely these elements are multiplied into each other by these numbers, they can in no way transcend the species; they will develop all the varieties of the fish tribe as the combinations multiply, but with the determinate tendency to make fish only. The next step in the ascending scale of definite relations, in order to maintain the unbroken connection of types, or links in the great

chain of being, instead of 1, 2, 3, 4, and 1–16th, which gave all the varieties of the fish and serpent tribe, we must take 1, 2, 3, 4, and $1\frac{2\,4}{1\,0\,0}$; these elements, when multiplied into each other, will give animals higher in the scale of being; and where the organs of locomotion were undeveloped in the inferior tribe, here they become organs of progression, and when multiplied into each other, give all the genera and species of the fir tribe.

The binary elements which constitute the structure of man are not united by the simple ratio of one binary atom to 2, 3, 4, and its fractions of 5, as in mineral and vegetable bodies, but leaping over the medial ascension of all inferior structure, 10 to 12 parts of one element are found to unite with each of all the others to make one binary atom of his structure, and these multiplied into each other will give all the varieties of the human race, starting in the first pair from the lordly Caucasian down to the African slave; from the Arab in his tent to the Teuton in his forest; the Greenlander in his boat to the Fin in his reindeer car; from the Norman in his ancient Scandinavian home to the stationary Saxon in the land of Horsa; not forgetting the aborigines of our own land, who, though annually diminishing in numbers, and drifting round like the last leaves of autumn, still remain a living monu-

ment of their primitive grandeur, in the inflexibility of their tempers and the wildness of their race.

GROWTH OF MATTER.

In closing the discussion of organic development we fall back again on the development of matter. The ocean at its birth was not the ocean it is now; its dimensions were less; maintaining definite relations at that period of its pilgrimage with the lower and inner strata of the earth, where we are now so eagerly engaged in searching for the geological periods of its ancient history. The ocean and the earth have since grown up together, burying the stone effigies of their dead march as they came along, till they have reached their present form and manhood, by feeding on the air. The air is the earth's foster-mother, from which it derives its chief support, its rich clothing of vegetable life, and the material substances of all decomposing trees, and forests, with the exception of the ashes, which remain after they are burnt, are derived from the atmosphere. In exchange for this bounty, this gift of vegetable life, the payment is made in the elements of death; the carbonic acid which we exhale is taken up by the air, and wings its way east and west, north and south, making the tour of the world. The date-trees which grow round the fountains of the Nile,

drink it in by their leaves; the cedars of Lebanon take it up to add to their stature; the cocoa-nuts of Tahiti ripen upon it, and the palms and bananas of Japan change it into flowers; and these perpetually dying and decomposing bodies add their annual deposit to the growth of the earth; and when countless ages have been given to the lease of its activity, gathering to itself new circles of matter from year to year, centuries multiplied by centuries is the sum of its growth.

MOTION OF THE EARTH.

All things, both in and on the earth, are in process of change, except its motion. Nature's motion is progression, progression is a force, force rises from power, and power is the same now as at the beginning, with its order undisturbed. The earth revolves now on its axis, as it did at its birth, once in twenty-four hours; and all other planets, born in the same circumstances, and under the same rule of action, moved in the same majestic harmony, and worked up to their time tables, with the same undeviating certainty that they do now. The motion of my body is the same now as it was in childhood, proportioned to the mass to be moved. The electro-magnetic force generates no more matter from its

condensing gases, than it can move, and the change in the masses of matter, by growth, cannot accelerate, or retard, or disturb the order of motion. The atoms on the surface increase in velocity in the ratio of the increasing diameter of the mass, while the revolution on its axis is the same, yesterday, to-day, and forever.

PRIMEVAL DEVELOPMENT.

But the order of motion in matter, differs from the order of its succession in development. When the Spirit of God moved upon the face of the waters, darkness was upon the face of the deep, and the first day was not yet ordered. Light followed, and when light was divided from the darkness, the evening and the morning were the first day. The language is remarkable—the verb let is a term for command, and holds the past in restraint. The narrative represents the Creator not as making a world, but holding its elements in check, till they should come in arranged in their proper order of succession. And God said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters. This order in the sixth verse, explains the affirmation in the second verse, "And the earth was without form and void." A

substance without form and void, has no existence, and this is verified in the fact, that the earth was not yet made. The order was given on the first day, and the dry land appears in the ninth verse, on the third day, and the firmament dividing the waters from the waters, on the second day. This firmament means that the four gases out of which matter was to be made, had not yet assumed their definite relations, but were still mingled with the waters which formed the face of the deep. These waters, holding in their molecules both the elements of earth and of air, were but imperfectly formed. When the oxygen of this water united with nitrogen, the firmament of air was made, and the oxygen and hydrogen left to themselves, was the sea of *fresh water*, out of which the dry land was to appear on the following day. Dalton found one part of common salt in one thousand parts of rain. water, in Manchester; Brandes found in rain-water, in the interior of Germany, common salt, chlorate of potassium, chlorate of magnesia, salts of ammonia, sulphate of magnesia, sulphate of lime, carbonate of magnesia, oxide of iron and oxide of magnesia; the chief of these being the constituent elements of sea water, brings incredulity on the stand to contemplate a sea as a laboratory, inclosing an electro-magnetic engine to disaggregate its mole-

cules of water, and render their tributary elements to the formation of dry land. Until hydrogen is decomposed we shall know less of the component parts of water, than is yet concealed from us. Leaving the scriptural history of primeval development here, we turn to the discoveries in science, to carry forward the rule of development to its crowning point in man. The four elements of oxygen, hydrogen, carbon, and nitrogen, the primal elements of matter, holding in their mutual relations the crucial problem of science, had already made space, and now directed by Him who made them the first special act toward our world, was the development of specific gravity, in the condensation of the two invisible gases of oxygen and hydrogen, which turned out a sea of water with its axial and equatorial arrangements in motion. (See page 29.)

The next process in this sea of development was the formation of crystals in the form of rock salt, and amorphous crystals, for sea-shells and shell-fish, and calcareous deposits, that the dry land may appear. All bodies passing from a liquid to a solid state, tend toward a regular geometrical arrangement into crystals under this given rule, namely: if the fluid be at rest, the axis of the crystal will be at right angles to the surface of condensation, or congelation, forming radii with

their bases in the circumference. Prof. Faraday has established the relation between the magnetic force and all crystallic bodies, and the magnetic force being a property of oxygen, is concentrated in water, and oxygen being a changing relation with ozone, makes water the embodiment of electro-magnetism, and electro-magnetism, in disaggregating the molecules of water, reproduces atomic forms in differing definite relations, and leads to the mooted question of

SPONTANEOUS ORGANIZATION.

The law of changing relations with equivalents includes reproduction and decay. Inorganic (insensate) matter has no organs of reproduction; but it lies in the direct channel of the electro-magnetic force which makes no two things alike. At the temperature of congelation water decomposes by electro-magnetism into crystals and snow flakes, turning out every one in differing forms, which is a spontaneous generation of new forms, with no organs of reproduction. If this germination of new forms of atoms may take place in the development of all crystallic bodies by the definite relations of oxygen and hydrogen, it follows by the rule of action of the same law, that with an addition of

nitrogen to oxygen in definite relations, the same force may germinate every variety and form of infusorial life without organs of reproduction.

There are five differing* compounds of oxygen and nitrogen, which stand in the following atomic relations to each other: Protoxide of nitrogen, $\frac{1}{8}^{4}$; benoxide of nitrogen, $\frac{1}{1}\frac{4}{6}$; hyponitrous acid, $\frac{1}{2}\frac{4}{4}$; nitrous acid, $\frac{1}{3}\frac{4}{2}$; nitric acid, $\frac{1}{4}\frac{4}{0}$.

Nitrogen, so nearly allied to oxygen by specific gravity, stands next to it in vital economy and motive force, and needs only decomposition by electro-agency to raise the veil which now partially covers the motive power of the universe. Not more than three-fourths of the mystery of organic life can be revealed while two out of four of its primitive gases are considered to be simple bodies. The instability of adjustment in all nitrogenized bodies and their easy explosion testify to a motive force, and it is questionable, when nitrogen comes to be decomposed, if it will not be found to be more intimately associated with ozone than with oxygen.

If we may speculate on this affinity, it may account for a mystery in the weight of the atmos-

* Kossuth introduced a new term, "peoples," which is acknowledged. Now if definite relations displace definite proportions, the old term "different" should be abolished, as nothing can be *different* which holds relations.

phere which now seems inexplicable. Two of the heaviest of the gases, oxygen and nitrogen, make up the lightest of all bodies, an ocean of air, while hydrogen, the lightest of all gases, unites with oxygen to make up the heaviest of all bodies, an ocean of water. But if the nitrogen of the air should turn out to have a greater affinity for ozone than oxygen, then the repulsion of its particles may account for the attenuation of its atoms as well as for its weight. As we are now opening upon the discussion of animal life, where nitrogen in its lonely simplicity plays so conspicuous a part, some speculation on its secret proclivities may be admissible.

We now have all the elements for infusorial life pre-arranged in definite relations with their rule of action; but as all attempts of the chemist have hitherto failed to make a grain of sugar from the elements of which it is made, how can he expect to make an infusoria. Where is the laboratory to inclose the material and machinery for the work? Down in that little 12×20 work-shop, with gas-lights in substitution for the sun's rays, with a little electro-magnetic machine, made by little finite fingers, and a little experiment is made to turn out a little shapeless arrest of development, in which a four million magnifier may detect life and motion, but which no one would contemplate a second

time, if placed beside the first-born infusoria from nature's workshop, which instantly gives the form and expression of design and definite purpose. The scale of work is the difference; what is magnitude with man is infinitesimal with God. If man could make an ice storm he would turn out crystals on a scale of magnitude which would unfold all the variety of forms and brilliancy of colors in crystallography. If he could make an ocean for his workshop, he would first turn out that beautiful crystal rock salt to adjust its rate of motion. This crystal so highly magnetic charges the molecules of water with a higher rate of motion than those which belong to fresh-water ponds and lakes, completing its work in the formation of the currents of these vast waters. Its rate of motion being adjusted in its atoms, the sum of the motion of its atoms being forced into its axial and equatorial arrangements, the planet is thrown into revolution, acknowledging its relations to all other bodies, and begins its great career in changing relations with equivalents.

While its rate of motion is being adjusted its internal arrangements are not forgotten. A deposit of amorphous crystals of a lower grade of magnetic force than that in rock salt, is found in the development of the carbonates of lime and of mag-

nesia in the sulphates of lime and of magnesia, and in the chlorides of magnesium and of sodium.

These lower grades of crystals form shells to maintain shell fish in lower degrees of life, and yet in the highest degree of perfection, while the infusoria, by the same rule of action, pour forth in spontaneous agreement to fill this dark domain with food prospectively, for animals higher in the scale of being, with organs for reproduction. Infusorial life bears the same antecedent relation to fish of larger growth, that vegetable life bears to animal life that feeds upon it. The ocean is the great depot for infusoria, and they may be always found at the bottom of brine cisterns, evolving what animals having organs of reproduction never do, *pure oxygen*. Spontaneous organization is merely the force of life in matter, under a given combination of elementary relations. No organs of reproduction are visible in animalculæ by the microscope, and none in the lower order of vegetable life; but higher in the scale of vegetable life are found male and female organs of reproduction, distinguishable from each other by the naked eye, and from this the organs of reproduction in the ascending scale of animal life, rise to their highest organization.

LIFE, WHAT IS IT?

From the physical demonstrations already made we deduce this result, namely, that the invisible relations of matter bear the same relation to its physical forms that the invisible relations of life bear to all organized bodies, and that this community of origin, community of elements, community of relations, and community of forces, should abolish the distinction predicated upon ignorance of the relations between organic and inorganic bodies.

Both have the same basis, and are equally organized in proportion to the number of combinations that enter into their structure, and they are made sensate or insensate by the lesser number of definite relations in the latter than in the former.

The secret of life was so profound that we never thought of looking for it in the commonest thing of matter. First among the ancient Greeks, we find Thales maintaining that water was the primal element of all material forms of matter and all varieties of life. It is a pleasure to know that kindred spirits may commingle in another life, and talk of their pilgrimage below; and I should like to give my hand to this old Greek, whose mind germinated the conception that water was a thing of life when the gaseous elements which made it were unknown,

when oxygen and hydrogen were sleeping in the problems of future centuries, to be disclosed to the world, as the world was preparing to receive them in the slow revelation of science. Eight-ninths by weight of water is life; call it what we please, the principle of life is life itself, wanting only manifestation in development. In tracing oxygen rearward our career is short. What is it but a binary compound with ozone. What is ozone in the hand of Him who wields all things? But, returning from ozone by binary compounds, we immediately reach a real entity in the condensation of two invisible gases of oxygen and hydrogen into water, the first-born entity of the physical world.

And what more appropriate emblem of life and motion than a drop of water, the first evidence of specific gravity, the first evidence of life, the first evidence of elasticity, and the first evidence of motion. What other entity or atom of matter presents, within its own relations, an organic force so thoroughly compacted for the imperial achievements which belong to a beginning universe.

SECONDARY FORCES—CRYSTALLOGRAPHY.

The most beautiful exhibition of crystallography is shown in hoar frost and ice storms. If the breath, at a given distance, is blown on a pane of glass, the

stellar figures of frost throw out rays from their centres, and branches of rays, all making angles of 60° with each other. If the temperature of the air is near to zero, the crystals multiply in such countless numbers, and starting up in separate atoms, that the order of their progression is lost. But when two or three separate crystals start up within the sphere of the stellar centre in the act of crystallizing, they are free to move, and their outer poles are attracted inward toward the sphere of the stellar centre of repulsion, and all will then be found in the same plane at the angular points of an equilateral triangle, since each must be at the same distance from each of the others. As a fourth crystal approaches in the same manner, it will arrange itself at an equal distance from each of the three others, at the apex of a triangular pyramid of equal and similar faces. It is seen, from this order of progression in crystallization, that geometrical forms are the necessary results of the electro-magnetic force, acting on this single binary compound, water, germinating new forms in definite relations in every step of its progress, until every variety of known forms are exhausted in their ever-changing relations.

We have demonstrated the digit 2 to represent the law of dual relations. The drop of water brings the law, with its rules of action, into matter; and

here we take our stand-point, that in this first substance, this drop of water, lies the secondary cause of all things, with the elements of their life and motion. Water takes its form, substance, and specific gravity from the condensation of its gases; apart from its gases it has neither form nor existence—ergo, matter apart from its water has neither form nor existence; ergo, it is water that makes matter, water that decomposes it, water that brings it into every new form and combination and mode of action of which matter is susceptible. Leaping over the hoar frosts, made by definite relations in geometrical progression, the next proof of these watery forms that we desire to lay before the reader lies in the crystals and their colors that water makes in ice-storms, which cover the blades of grass and trees with their crystals, and exhaust all the admissible permutation of changing relations, in the beauty of their transitive forms, and the brilliancy of their changing colors, and in obedience to the law that water in crystals can reflect no two colors alike, it can make no two crystals or things alike. Over any given area, where the snow may be ten feet deep, no two snow flakes crystallize in the same form.

In vegetable life it makes no two plants, or flowers, or shrubs, alike. There is no tree in the forest

that observes the same curve in its arches; no two leaves on the same tree that may not be told one from another. In human life, it makes no two beings alike, and no sensation alike, nor any two minds alike that spring from sensation; and the moral natures diverging from these never take the same pathway. And in this ever-varying, and yet agreeing beauty (the waters being lost in the spread of their relations), it is by long attention only, that the conception of its presence, hinted at by all things, yet assumed by none, is fixed upon the mind as the standard of truth—that in water lies the physical forms and vital forces of the whole physical world.

Leaping over infusorial life with no organs of reproduction, and animals in the ascending scale of being which have them, our next proof will be found in human life, in the proportions of its water to its tissues.

This is given by taking the average proportion of water in the brain, blood, blood-cells, and muscles. Brain has $\frac{72}{100}$, the blood $\frac{87}{100}$, blood-cells $\frac{76}{100}$, and muscles $\frac{85}{100}$. The average proportion of water in these four relations is $\frac{80}{100}$, which gives four-fifths, by weight, of water to the tissues, and leaves $\frac{71}{100}$ of oxygen for the generation of heat and support of life. This primitive adjustment of oxy-

gen for the maintenance of life and heat has been overlooked because it was inclosed in water; and the whole science of life, in its relations to matter, has been thrown into confusion by this mistake. Respiration, as a source of animal heat, has been entirely misapprehended. Instead of being known and understood to be a cooling process, it has been taught to every medical student to be a heating process, when every breath throws off 16 parts of oxygen to 6 of carbon. It is well known that the generation of animal heat is the most important function of animal life, and in the present state of medical science it is the least understood.*

This $\frac{71}{100}$ of oxygen makes $\frac{80}{100}$ of water in the tissues, which is the constituent element of human life, and the starting point of its electro-magnetic force in the construction of its motive power. The *motive force* of all living beings is centred in their muscles, and more than four-fifths of the solids of the body are muscular. The upper and lower limbs, as well as the trunk, are constructed with muscles, and all the internal organs have their muscular coats, and the whole muscular organic force has $\frac{5}{100}$ parts of water above the average standard of the solids of the body. All are more or less acquainted with the anatomy of a muscle—

* See Appendix A, Respiration.

that every muscle terminates at each end in a tendon, and that these tendons, at each end, are inserted into bones, and the central part is the spring. When this central part contracts, there is a strain upon the whole, and a direct force is exerted to tear the tendons from the bone. There are, therefore, two strains upon the tendons at each end of the muscles, the central part only being elastic; and when the action and reaction of these fibres become exhausted by over-work, the water in the fibres is reduced in proportion to the loss of strength in the muscles, and they feel stiff, and sore, and lame, and full of cramps, and the spring is gone; and this want of tone and diminished strength is not renewed till a period of repose has restored the adequate supply of water to the standard of its adjustment at $\frac{75}{100}$. The spring and strength of a muscle depend entirely upon its supply of water. Lassaigne has shown that the percentage of water is greater in infancy, less in childhood, adjusted in manhood, and drying down in the decline of years; and this accounts for the perpetual motion and elastic spring of childhood, the steadiness of adult age, when polished canes are used only as a fashionable appendage, forgetting, as he stalks by the bent old man, whose stick is as dry and inelastic as the body it is bearing towards his home, that he himself is changing into

the same picture, and another is coming up behind him to pass *him by* alike unheeded, on his own weary pilgrimage to the grave.

But the standard of adjustment for a perpetual motive power is found in the action of the heart and arteries. These are beating time, on a scale of magnitude, from the cradle to the grave, which eclipses all other forces in the physical world; and yet, like all other forces, its base of operations is invisible to the naked eye. The water pulsating in the tissues before the blood-cells are made, is the starting-point of the forces. The question may here be asked, how water, whose drops are of a given size and form, can be thrown into such infinitesimal relations. We answer, that the atoms of water, like the atoms of quicksilver, preserve their form in subdivision, wherever the microscope has traced them, even in the formation of a crystal, where the globular form of water is still maintained. It is the maintenance of this form which gives the elastic spring and motive force. The action and reaction of all elastic bodies is exactly equal in opposite directions, and they retain the motion which they receive from their elastic force.

MUSCULAR FORCE IN THE HEART.

Pennock says the ventricular cavity of the heart will contain a hen's egg, and its four cavities are nearly equal to each other, and that the walls of the left ventricle are a little more than double the thickness of the right ventricle. It is observed that the four cavities of the heart are equal to each other in the quantity of blood they hold, and the two ventricles are unequal to each other in their motive forces; the walls of the left ventricle being double that of the right, give a double motive force, each force being proportioned (not as in inorganic bodies) to the resistance to be overcome; but, like a row of firemen handing buckets to each other, every blood-vessel from the aorta onward, through the returning vena-cava to the heart, has its own muscular coats; the wave it receives is pulsated forward to the next in order, and all have their equal share in maintaining the general circulation, by the force of the oxidation of the waters in their several tissues.

BLOOD.

The blood-cells have $\frac{68}{100}$ of water, but the blood globules circulated by these organic forces have $\frac{87}{00}$ of water, which is $\frac{2}{100}$ above the driving

force of the heart and arteries, and $\frac{7}{100}$ above the average standard of the solids of the body, showing a cumulative force, from the passive power in its cell, to the highest rate of motion known in organic life.

In looking further into this force, its dried elements are found to differ essentially from any or all of the forces we have been demonstrating. Made up of the condensed forces of the four gases which constitute the crucial problem of science, it is the crowning point of motion in organic life.

As these gases in the dried state stand to each other in their following relations, Carbon $\frac{52}{100}$, Nitrogen $\frac{15}{100}$, Ashes $\frac{4}{100}$, Hydrogen $\frac{7}{100}$, Oxygen $\frac{21}{100}$, they present a very extraordinary analysis for the highest production of motion in the tissues; and if the analysis be true, as it is accepted to be by science, both Nitrogen and Carbon may claim their respective shares in the production of water, and water will hold within its molecules a still greater mystery than has yet been disclosed to us.

The proportion of water as a constituent element of brain varies with age. In infants it is $\frac{82}{100}$, youth $\frac{74}{100}$, adults $\frac{72}{100}$, old age $\frac{73}{100}$, idiots $\frac{70}{100}$, with fractions off, idiots' brains having less water than other brains; but the standard proportion in a healthy sound brain is $\frac{72}{100}$.

It would seem at first sight surprising that this organ, which distinguishes man from all other beings, should fall $\frac{5}{100}$ below the highest standard of organic force in the adjustment of human life. But there is a law in organic life, that in every mental process there must be an attendant organic process, and this low standard of organic force in the brain enables it to adjust its definite relations in arithmetical progression, and write out the slow records of its testimony.

This organ has hitherto been put into Sir Isaac Newton's centripetal force, and has been held to be the centre of the nervous system, than which nothing can be further from the truth. Grant this (worse than idiocy), the brain would become the vivid centre of the vivid forces of the nervous system; the tables turned, reason dethroned, and confusion less confounded, would stare at the fragments of mind standing in such altered relations to each other.

The nervous, medullary, and cerebral systems are three differing systems of relation, but physiology identifies them all in one relation, and testifies the brain to be their common centre. For this reason there has been no analysis of the nerves of the solar centre, supposing the proportions of water in their tissues to have been given by the brain. But

the high rate of motion in these organs must give a greater proportion of water to their tissues than the brain, unless the fact of their being transmitting instead of motive forces should alter the relations.

Each nerve is organized with a centrifugal and centripetal tube, with no apparent difference in their structure, and as they are made by the same motive force of action and reaction, they can never assume each other's function. But the velocity of motion in these tubes, by the experiments of Hilmpotz, rates at 200 feet per second in man, which is much less than the rate of motion of electricity in a metal conductor, and this would lead to the inference that, being transmitting, and not motive forces, the proportion of water in their tissues was low.

Still, the three systems of relation are so nearly allied to each other that they may be discussed together, keeping them as nearly as possible in their several orders of relation.

It is well known to all that the nerves are developed before the spinal column, and the spinal column before the brain, and that they rise from the solar centre, and go to the spinal column and to the brain; that is, their organic force is centrifugal. The mystery in the nervous system rises into form at this point in confounding and condensing the three organic forces into one. We should

adopt the same rule in physiology that we pursue in every other thing appertaining to complex relations, viz.: that organs which differ both in structure and function should not be identified or confounded in their relations.

The structure and function of the nerve is known to differ essentially from the brain. The nerve is known to be the source and centre of sensibility, and the brain to be devoid of it. No men knew better than Gall and Spurzheim that sensation, the element of the affections, emotions, and passions, was wanting in the brain. It was this misconception, that it was the focal centre of sensation, which led Gall, with a generating power of reproduction in error, to magnify the error, till it came to be a phantom of the imagination. In his honest and ardent impetuosity, he brought all the powers of a gigantic intellect to bear, like a burning focus, on the brain, radiating its light through its dark and hidden channels, hitherto untraversed by the human mind, till the vivid impressions of his own imagination were kindled deeply into public opinion. True, his dissections and examinations have thrown a standard light upon the anatomy of the brain; but his theories have confirmed and condensed the mantle which wrapped it in its primitive darkness. Supposing that he had found

the sum of the nervous force enclosed in the brain, his imagination painted every fibre with the vivid emotions of the vivid senses of his mind, till, like Helio contemplating the beautiful statue in St. Peter's, he conceived it to have life, and, fired with its beauty, committed suicide in despair of possessing the object of his love. The medulla oblongata cuts off all nervous communication with the brain through the medium of the spinal marrow.

The nervous system, like all other systems, is a unit in centres of circumference, with mutual relations and dependencies. I foresee that the Lethean sleep in the medical mind will be awakened from its slumbers in the meshes of the nervous system, when I propose to show that, instead of representing it as a skein of tangled yarn, with knots and angles demonstrated backward, it is but a single nerve with two branches. The Law which brought us here, with its dual relations, is as true to its trust in the nervous system as elsewhere. Like the sturdy oak or lofty elm, each, like human life, has its roots in a cell, and each at first shoots up a single shaft, and then, like the nerve, it throws off a brace which divides its trunk into two similar, yet different parts.

Every animate existence springs from a germ, and the proportion of water in its cell, like that of the oak, is the standard of its vital force and mo-

tive power. The germ makes its cell, and its wall being elastic, by means of its water, it pulsates. These germs differ from each other in their simple or granulated forms.

The germ from which human life is developed is made up of fibres in the form of braces, with springs in their centres.

The cell having the proportion of $\frac{80}{100}$ of water in its fibres, is the standard of sensation and motion. Within this cell, and on one side of its utricle, are found granular tubercula, from which the solar plexus springs, which consists of a dense mesh-work of nerves and ganglia radiating nine plexuses of nerves from its central battery of human life, charged with sensation and motion.

In the centre of this solar plexus is the cœliac axis, with the two semilunar ganglia, one on each side of it, being the largest ganglia in the body, and giving birth to the greater and lesser splanchnic nerves. If the greater splanchnic be demonstrated centrifugally (that is backward), through the medium of the great sympathetic, and the lesser through the medium of the so-called pneumogastric, and all backward through the eighth pair to the medulla oblongata, they will represent the physico-mental nerve, one branch of which makes the mind, and the other the matter. These branches, rising

from one base, are joined to each other, on the inner side, by branches from the solar plexus itself; the lesser, the mental branch, joining the cœliac axis at its root. Thus armed, this nerve is the matrix of the nervous system, whose motion, *in pulsation*, constitutes the action and reflex action which, when carried out from its nucleated point to its widest spread relations, is the action and reflex action of the whole nervous system first seen by Hall. Having arranged the great registering ganglia of human life, in sensation, circulation, and voluntary motion, the physico-mental nerve rises from the solar plexus, and works its way, as the adjacent organs are developed, toward its terminus at the floor of the fourth ventricle of the brain.

Endowed, as it seems to be, with the power of choosing and refusing, the order in the distribution of its branches *in time* is not in accordance with the succession of the branches which it afterwards throws off in its course to the brain. It passes by the stomach and gives its first branch to the heart, which is seen to pulsate its own development, without the presence of red blood.

Then, as its central line is continued toward the brain, and the trunk of the body is being outlined, our attention is called back to two vesicles of red blood in the ventricle and origin of the aorta, which, like

their antecedents, pulsate; and then, looking upward, three focal points are seen to be gradually unfolding, the cerebellum, cerebrum, and bill of the chicken, and they gradually approach (attract) each other to form the head. Now the auricles are found to be drawing in nearer proximity to the heart; and as the liver is developing its structure, the combination of organic forces begins to show voluntary motion. Then what have been supposed to be primary organs, the stomach and lungs, turn out to be secondary developments, and these are followed by the grouping of the intestines, loins, and spinal column, and then the upper jaw appears, the lower having been formed; next in order of time, the ventricles of the heart appear, with two drops of blood, obviously beating on their own account; and a closer inspection discloses the action and reaction of these vesicles to be maintained by the decomposition of water in their tissues. After the ventricles are adjusted and the general circulation established, the arch of the skull is sprung; and with its floor laid, the medulla oblongata, which is the upper and enlarged part of the spinal chord, extends from the upper border of the atlas to the lower border of the pons varolii, with its anterior surface resting on the basilac groove of the occipital bone, and its posterior surface in the fossa between the hemispheres

of the cerebellum, forming the floor of the fourth ventricle of the brain ; here it is joined by the physico-mental nerve—and thus far it has been playing hide-and-seek with the human mind—its pre-ambulating step shedding no light on its per-ambulating relations. And lastly, when the two hemispheres of the brain (the final combination of dual relations) complete the structure, the sense of touch is finished, with its organic force on a level with the adjustment of the brain, which is simultaneously filled up. Here, in the development of the sense of touch in its connection with the brain, we have crossed the line from the animal to the infant development, and now we pause to call the attention of the reader to it. The organization is completed, and the infant, with $\frac{82}{100}$ of water in its brain is to be reduced in twenty years to $\frac{72}{100}$, to give the firmness of adult age. In reviewing its structure, it began, as all other bodies begin, at its centre, and finished at its circumference, which proves its force to be centrifugal. It began in power and ends in forces; and like all other bodies from the atom to the globe or a solar system, its radial forces, when multiplied into each other, give the sum of their several proportions of power.

The rule of action displayed in this physico-mental machinery of the infant, is seen in a clearer

light, if we liken it to that stellar crystal of hoar-frost, which starts upon a pane of glass when the temperature is below freezing. That beautiful little star like the infant springs from its cell, and like the infant its crystal springs from the side of its cell, at an angle of 60°, and the triangular spaces are bounded by sides making the same angles with each other, with their bases in the circumference, whose angles are arcs with their changing relations in progression. While we are beginning to describe this little stellar development, it has covered the glass with its crystals, and like the infant has concealed its footsteps in its complex relations. If the reader recurs to the development of the chick from its egg, he will remember that it, too, threw out centres of circumference in triangular forms, in its cerebellum, cerebrum, and bill, and as these centres were forming, they were gradually drawn (attracted) in, till their prehensile relations dove-tailed into each other and made up this beautiful symmetrical head, while the grouping of all the differing organs of the body observed the same rule of order. In the physico-mental relations now developed, there are two points demonstrated, remotely from each other, for the exercise of the physico-mental faculties. The brain is the council chamber for the exercise of the reason and judgment, and the solar-

centre for the sensational exercise of the moral affections. It is shown that the brain of the infant must go through a long series of organic changes in successive years before this organ is fitted for the exercise of intellectual analysis, and that the infant must be contemplated as a sensational and not yet as an intellectual being. That we must now establish the physical arrangement between its outward perceptions of the external world with their internal relations to the solar-centre, as if it had no brain; and when these sensational relations are completed, the mind of the infant will be adjusted to its physical relations.

The organic forces which preside in the face are the senses of taste, smell, and sight, and the hearing in the base of the skull is on a line of development with the vision.

These are all formed before there is a deposit of brain on the floor of the skull, and before the fingers are made for the sense of touch. They are all vivid senses, which gain and give up their sensations to the memory on the fleeting moment as it passes by, while the sense of touch is less vivid and more lasting, slowly weighing its testimony in arithmetical progression and in equal quantities. It is at once seen that perceptions so differing in their sensibilities, but more especially in their rates

of motion, cannot have the same focal centre for their different theatres of action.

The vivid senses must have a vivid centre, whose organic transitions are in exact correspondence with its rapid motions; while the sense of touch must have a *table* on which to write out the slow records of its evidence.

The sympathetic division of nerves in their primary branches are distinguished for their plexiform relations to the blood-vessels, glands, and viscera, to which they are distributed, and for uniting with other larger ganglia in each of the great cavities of the body; and are also found on the great angles of subdivision in the large blood-vessels and plexuses of nerves proceeding from these secondary ganglia accompanying blood-vessels, and send branches to the spinal column, arranged in a series of ganglia placed on both sides of it, from the coccyx to the cranium. They consist of tubular and gelatinous fibres, inclosed in a sheath of fibro-areolar tissue. These branches of the sympathetic, in their interior constitution, are marked, some by a gray, and the other by a white color. The white color has more tubular and less gelatinous fibre. The gray color has more gelatinous and less tubular nerve fibres. The rate of motion in the latter will be found to be higher than in the former.

The medulla, which is the middle substance between the spinal marrow and the brain, and stands as the antecedent of the brain, differs in structure and function from both relations. This organ is distinguished by properties which mark its peculiarities with deep interest. In it are found no nerves, and yet there is found in it the terminus of the motive force of the nervous system reflected backward into the spinal marrow, with an accessional power inversely as the force of the advancing current. It is also ascertained that this substance reflects both motion and sensation, with more force than any other substance in the body. And this is in accordance with the great law of nature. It is the light reflected from all crystallic bodies which constitutes their beauty, and the higher reflection of the diamond which gives its value. It is the reflected light of the sun's rays which we receive from that great luminary, which has passed through a series of countless ages to put its focal centre into man. It is not the direct, but the reflected rays of the infant which gives its charm and beauty; and so deeply impressed in the mind of a child is a child's beauty, that it is perpetually striving to make model babies to look like it, till drawn away by the brain on its plane of elevation, hinting to it truths of higher order, mingling them into new

forms in definite relations, till the accumulations of *to-day* lead the child to higher expectations of to-morrow, and it begins to radiate its own reflections in the maturity of its growth. But we have not yet done with the medulla; its prolongation by means of its corpora pyrimedalia connects it with the crura of the brain, and it is admitted to carry forward no property whatever of *sensation*. Hence the medulla is the doorkeeper of the brain, to protect its council-chamber from the passions and emotions resulting from disturbed sensations. Having isolated the brain from the direct force of sensations through the medium of the spinal column, and cleared the motor track from the medulla through the great median fissure under the hemisphere of the brain, where its nervous connections hold changing relations with the vivid senses of taste, sight, smell, and hearing, we are now prepared to unfold the sensational relations of the infant with its perceptions of the external world.

When we left the solar centre it was radiating sensation, circulation, and voluntary motion, and voluntary motions imply acts of the will, and acts of the will presuppose a memory.

Professor Draper, speaking of the retention of impressions (p. 269, Physiology), says, "Our attention cannot fail to be arrested by this last effect;

for if there be a property which is characteristic of the nervous mechanism in its utmost degree of development, it is this of retaining the relics or traces of impressions which have formerly been made upon it. As it goes on increasing in perplexity as we rise in the scale of being, the provision for the retention of such impressions become more and more strikingly marked. Ganglionic masses, which, from their position and structure, are marked out for this duty, appear in their ascending scale of magnitude. To these we may aptly apply the designation of registering ganglia, since they truly store up the traces of gone-by impressions, and keep them in reserve."

These registering ganglia thus introduce the element of time into the action of their mechanism, and the duration of this action depends upon the vividness of the impression made at the passing moment. The memory is a sensational and not an intellectual faculty, and belongs exclusively to the vivid senses whose focal centre is the solar circle, where circulation and voluntary motion are established on their own scale of permanent relations; and now sensation, rising on its plane of elevation, gives birth to consciousness. Sensation and conscious ness of sensation, being the first experience of life, we pause here to consider both sensation and volun-

tary motion, the prior relations of consciousness, that our terms may not be loosely defined or imperfectly understood.

Sensation, in its ordinary acceptation, means a feeling; but what is a feeling, if it be not a property of life held in common by every thing which moves. Sensation has been known for many centuries to be the ancestor of many nations, but in the profusion of its wealth, it has not yet been suspected to be the mute shareholder of motion. The hieroglyphics on its door have hitherto concealed its footsteps. When read, they are bars in the form of braces, for the construction of matter. When the door is opened, its cell for the construction of organic life is found to be in fibres of delicate workmanship, in the form of braces set in angles of definite relations. The average proportion of water, the standard of sensation in this tissue, is $\frac{80}{100}$ of water, to $\frac{20}{100}$ of tissue.

VOLUNTARY MOTION.

This is a misnomer. The will has nothing to do with motion, but to guide it—sensation produces motion, and the motion is guided by the will. When we sleep, the will sleeps with the *rest* of the functions, and we perform all the motions, when the will is unconscious, that we perform when awake under its guidance. Nor does the will ever hold

any control over the circumstances which determine it.

The will acts on belief; whether the antecedent circumstances be right or wrong, it makes no distinctions, it acts with an energy proportioned to the force of belief in the antecedent circumstances which determined it, whatever they may be. The will is only the executive agent of these antecedent circumstances which have combined, without its prevision, to send it on an errand of mercy or treason.*

* If theologians would accept this definition of the will, they would set themselves right with the sinner. Now they are preaching repentance to a will which has no power to obey. Belief stands in the human mind before the will—repentance never—no man has ever repented first and believed afterward.

When God was making the world, at the close of each day He pronounced it good, not better, not best, and as far from perfect as the relations of good stand to perfection. All things both in heaven and earth were imperfect, and any thing made imperfect must necessarily run down without the intervention of the maker.

Jesus Christ, the Son of God, has intervened to save all things that were made, and man is included in the great salvation. Without stopping to discuss the necessity of this intervention, all are assured of its truth. Science stands side by side with the Scriptures, in proof of its verity. All that is asked of man, is simply to believe, not to repent—for he does not yet know what to repent of till he believes—but to believe that Christ the Son of God died to save him. If he believes the Saviour died to save him he will be sorry that another suffered for him. If salvation is offered through the medium of this belief, with no conditions except to believe, it is his own business if he refuse it;

In the construction of muscle it is $\frac{85}{100}$ of force to $\frac{15}{100}$ of tissue. It is already shown that the framework of man is chiefly constructed with muscle, and every muscle is a brace with a spring in its centre. But the highest standard of life and motion is found in the blood, with $\frac{87}{100}$ of water to $\frac{13}{100}$ of tissue, its rate of motion being $\frac{2}{100}$ above that of the muscle, and unlike all other organic forces, when its motion stops it is instantly dead. The changing relations between the muscle and the nerve develops sensation in the one and sensibility in the other, but the rate of motion in the nerve has not yet been measured, and its standard of sensibility is known only by observation and experience; while the brain, the centre of intellectual power, holding mutual relations between the nervous and muscular systems, is *fibrous*, deriving no sensations from either of these relations.

The motive power of man is measured at its average standard, by $\frac{80}{100}$ of force to $\frac{20}{100}$ of mate-

but if he accepts it, he is saved. The feeling of safety is a repose in belief, which brings with it confidence, hope, expectation, and altogether germinates faith in Him who saved us, and faith is the increment of a growing belief in a Saviour. He will care for nothing but His service. Every trial of to-day will be lightened by the expectations of to-morrow, and the anticipations of the inheritance in store for him. The antecedent circumstances having set the will right, its acts will be right, and he is a new being.

rial, and the degrees of deviation from this standard are comprised within $\frac{72}{100}$ and $\frac{87}{100}$ of force to the standard. The muscular system has $\frac{85}{100}$ of force to $\frac{15}{100}$ of material; the blood, $\frac{87}{100}$ of force to $\frac{13}{100}$ of material. The brain, $\frac{72}{100}$ of force to $\frac{28}{100}$ of material.

What a lofty range of sensations and motions are comprised within the definite relations of $\frac{72}{100}$ and $\frac{87}{100}$ of force!

Within this range is the great field of human development, and none but the poor idiot is left without its pale, but he is included in its sympathy.

Within these degrees of deviation from the standard of $\frac{80}{100}$ of force are found all the sensational, intellectual, and motive powers of the human race. If we contemplate man in his primeval state, made up of this range of elements of life and motion, we see that his hands were his only instruments, the heavens his only covering, and the earth his footstool; yet in his mind, blank in experience, was planted the germinating model of every motive force, and every form of machinery, with every instrument of construction which could contribute to his necessities, and afterward to the luxury of his life.

The first rude construction of his motive force was centripetal, and consisted of a water-wheel, whose force worked from the circumference to the

centre. I should have referred this form of force to the poverty of the age, if Sir Isaac Newton had not converted it into a general law, which soon originated patent rights for motive forces working centrifugally.

These dark problems were thrown before the human mind at that early age, to exercise its powers for a higher state of being. Its first experience was to throw off a rude model. In this was found a mixture of truth and error, and the mind, working by the Baconian rule of induction centuries before Bacon was born, saw the error of construction, and, moved by his *sensations* of delight in the discovery, threw off a new model with the errors out. In examining this model, fired by his sensations, he saw a better model in his mind, and threw another model off with another error out. If we pause here to examine the process, we shall see that he was not working by the outward model, but by the new one in his mind. He had discarded the old one for its errors, and adopted the new one with its errors out, and thus he is seen working his way to truth through the medium of errors, which is the highway of his pilgrimage of life. When he made the steam-engine as it is now constructed, he made the daguerreotype of his own motive forces. Give it sensation and railway plates, and it would be self-

motive. The telescope too has reached a high state of perfection, modelled after the human eye, whose high rate of motion is derived from its crystalline lens and capsule being made chiefly of water. The analysis of this aqueous humor, consisting as it does chiefly of the chloride of sodium, is a significant hint to the chemist as well as to the occulist. Bacon's imagination painted to his own mind the method of its own working power, and this is called the Baconian philosophy; but we see the same rule of action in the mind of the simplest mechanic, when working at his ploughshare. Every daguerreotype which the mind throws off from itself is a process of reasoning by induction, approaching nearer and nearer a first cause, but guarded with the rule that we shall never reach a first principle.

Having established the relations between sensation and motion, and defined the power of the will, we return to the hieroglyphics on the door-plate of sensation for a clearer conception of the construction of matter. The reader has not travelled thus far without gathering impressions, hinted at by all things, yet assumed by none, that the construction of matter is in centres of circumference, with angles of definite relations in the forms of bracework, and this is shown in the primitive cell of organic life, whose fibres are braces with springs in

their centres. If he will go back a step further, he will find, on p. 83, in the formation of the central organs of the body, centres of circumference thrown out by the forces which form the heart.

Its ventricles and auricles are forming at given distances from each other, and having reached a condition of separate organization, they are gradually drawn together, and their forces unite into one focal centre. So with the brain: three centres of circumference were seen forming at given distances, and when each centre had completed its structure in proportion to its forces, they were each drawn into one common centre, as a unit in agreement with its parts. If we take another step backward, the same rule of action holds good in the bones, for the adjustment of the soft parts to its solid framework.

The vertebral column and base of the skull are the first parts of bone that are developed in embryo. The vertebræ form centres of circumference, whose centres are in each other, and they unite in the form of a ring in their circumference, to form a channel in their centres for the passage of the spinal marrow, and each of the vertebræ are formed from three primary centres of ossification. The sternum has six centres of circumference. The os innominatum, three primary, and five secondary centres.

The scapula seven centres. The femur itself five centres, and the tibia and fibula each three centres of circumference. This is the rule in the formation of every atom of matter, that the centre of its circumference is in angles of definite relations in the form of brace-work, and this rule of action is carried forward in the ascending scale of being under the great law of universal causation.

Every angle, in whatever form it may be drawn, is a brace. Every deviation from a straight line must be met with a corresponding deviation in the shape of a brace. Every angle in science is exhausted in each system of relations in the human frame. In the centres of circumference of the branches of the nervous system, and of the blood-vessels, bones, and especially in the brace-work of the muscular system, every step is met by angles of relation. It would seem as if astronomers, in the use of the term angle of incidence, were thinking of the lines they are drawing in the heavens as ideal, yet they use these angles as material forms to show the brace-work of the heavenly bodies. They may say there is no force in these lines, but what gives more force to the mind than angles drawn by the fingers which demonstrate relations? They represent material forces in the mind, and show the relations which material forms hold to each other. All

forces are invisible till they unite to form matter, and the invisible angles of these forces are the moulds of the visible forms of matter. The four gases, of oxygen, hydrogen, carbon and nitrogen, have their invisible angles of relations prearranged with each other, as the prototype of the form they are about to develop in matter, and they are no less material to our senses than the angles of incidence drawn upon paper; and but for these gases, we should have no forces in space on which to draw angles, and no prehensile relations between the forces in space and the bodies which float in it. The little star of hoar-frost on a pane of glass, which hastens to cover up its footsteps with a polished glade of ice, stands, in its angles of definite relations, the prototype of the brace-work of creation. The axial and equatorial arrangements in the interior constitution of the earth is a system of brace-work in angles of definite relations. And in looking off from the little globe we occupy, to contemplate each globe as the aggregate of its own atoms in centres of circumference to itself, the globes themselves become atoms in their relations to the sun, the solar centre of circumference to the solar system itself. Philosophers are daily demonstrating the relations which bodies in space bear to each other, by angles of incidence, which mean nothing more

than angles of relations in centres of circumference; and they are aiming to bring every relation to a centre in the sun, to clinch a point of rest in some *simple* body there, for Sir Isaac Newton's attraction of gravitation to rest on. But if the sun is the centre of the circumference of the solar system, each group of that system is a centre of the circumferance of the sun itself; the sum of attraction in the circumference being equal to the sum of repulsion in the centre, leaves each system of relations freedom of motion in its own sphere of action, and the last hope of poor Isaac is gone.

The whole mystery of the force in centres of circumference lies concealed in the insignificant term *radiation*.

A central body, heated above the standard of surrounding matter, radiates heat in the geometrical ratio of the loss of its heated mass; and as the surrounding bodies are filling up in their centres of circumference, at the approaching point of equilibrium, the primary mass is receiving as many impulses from the surrounding bodies as it sends off from its own surface; and the general adjustments of bodies in space, as well as of bodies in themselves, is maintained by the mutual radiation of forces, proportioned to the masses of matter in motion.

Bodies which are moving in space, in centres of circumference, are only the visible forms of the invisible forces which made them; *types* of its invisible self; and the forces in centres of circumference in definite relations having primary centres, whose forces are centrifugal, must maintain these bodies in motion to the end of time.

Having brought up the physical relations in advance of the moral and mental states, we return to the infant left with the consciousness of sensation. The reader will observe that we use material for the convenience of demonstrating forces, and place but little emphasis on the details of matter, that we may absorb all attention to its forces. The infant just cut off from its primary state of being, is entirely dependent for the succession of its phenomena on the sensations of nutrition—treating it as if its brain was laid up for future use. The first natural sensation it has, upon which sensational succession in phenomena can be predicated, is that of hunger.

It has as yet received but little knowledge from the external world, through the medium of its outward perceptions. The eye, by wrong adjustment, sees all things inverted—the smell distinguishes no odors—it hears without discriminating sounds—its touch discerns no properties in bodies; but its taste

alone is true, and this truth binds it imperishably to its mother. Whatever else is wrong or in confusion, there is always the perception of truth in its mother.

Of hunger it must be conscious. The *sensation* and *consciousness of it* co-existing, constitute its first experience. Whatever may be the diversity in human character, in this, their beginning experience, they are all alike.

When the child nurses it combines its internal sensations with the outward world, and the blending of its mother's milk with its gastric juice gives the first sensation of hunger gratified; and this is its second experience.

Here children begin to differ from each other in the ratio of their differing digestive sensations, and the diversity of character begins. The child now remains stationary, till repeated experiences within very narrow limits gradually develop the element of *association* (in its gratified hunger) with its mother. Then the weak memory of the past, rising from repeated assurances of like sensations in the ganglia, takes its place in the order of its succession from sensation between consciousness and association, and they stand in this order of sensational succession: sensation, consciousness of sensation, memory of sensation, and association of mem-

ories of sensation. These are the elements which arrange and retain the past sensations of the mind; when the imagination, with its exhaustless supply of material, introduces the future, spreading its own sensations in indiscriminate profusion over the sensations of the past, persuading them to believe in it. Now we have sensation, consciousness of sensation, association, memory, imagination, and belief, with the will to guide it.

These are the elements which constitute the moral affections of infancy. In their happy state, they are all joyous sensations reposing in belief.

Here we pause to compare the relations which the moral affections of infancy bear to the sensational affections of animal life. The animal, like the infant, acts on belief, and with the same antecedents to produce it. Its belief has degrees of deviation from its standard, but like that of infancy never amounts to unbelief. Unbelief, when traversing belief, argues thought above instinct. The animal has but four perceptions to connect its internal sensations with the outward world—sight, hearing, smell, and taste—and these are all vivid perceptions, which gain and give up their sensations to the memory on the passing moment. The deer, whose safety is in his vivid perceptions, acts on the belief that his defence is in flight—with a telescopic

vision, which the sagacity of man can only avoid by concealment, an ear which vibrates on the turning of a leaf in a summer's sun, and a nose which scents his foe beyond the scope of a Minie rifle—is happy in his belief. But the child needs no such protection; it is born in the lap of care, surrounded by sympathy, watched by intelligence, and reared prospectively, in slow development, for time and for eternity.

But childhood, the continuation of the antecedent circumstances of infancy, brings us to the centre of the circumference of the moral relations completed, and in preparation for manhood. Here we find the sensations disturbed by unbelief, and the conscience rises (not as a guiding, but the adjusting faculty of the mind) out of a prior transgression. Belief stands before the will, and conscience after its action.

This is that vivid period of childhood when the imagination introduces the future, with its prehensile visions, persuading the memory to take them up, and the association to weave them in, and if the weft corresponds with the vision, it believes in it, and sets up the will to wear it as the garment of the mind.

The imagination stamps the moral relations with

its own seal, as the perceptions of touch stamp the intellect.

Before the imagination has been soiled by contagious associations, it is a furnishing angel with its beautiful imagery in outlines of innocence and love, but when fallen, it is a scavenger introducing all sorts of material, and deceiving the mind by the sensations they produce.* The child is now in its gradual transition from lower to higher states, with more experience in the use of its faculties; and the wisdom with which we adapt our instructions to its altered circumstances, depends much on our prevision of the altered condition of its brain.

In infancy, its brain has $\frac{8}{100}$ of water, in childhood, $\frac{74}{100}$ and in adult age, $\frac{7}{100}$—our laws limit childhood to eighteen for girls, and twenty-one for males. Both experience and observation have sanctioned this rule. If we divide the periods of male childhood into three parts, and call infants 1, childhood $10\frac{1}{2}$, and adult age 21, it will show a loss of $\frac{8}{100}$ of water from infancy to ten years and six months old, and only $\frac{2}{100}$ loss of water from ten years and a half to twenty-one years old.

* Belief and unbelief, ability and inability, depend upon the degree of deviation from the standard of adjustment in the imagination with its relations. In its estrangement from the memory of its past associations, it is cut off from its anchorage, and insanity is its home.

Admitting this statement to be true, (which should be modified by a further experiment,) what a critical period of preparation for a being who knows not what to believe, and yet whose prospects are so vast that its boundaries are undefined. Unbelief is the necessary result of not knowing what to believe; and at this period, when the waters of life are superabundant, the association of ideas arising from the sensations which the differing perceptions introduce have nothing to govern them.

The judgment is not here, and they take their course uncontrolled and unregulated, playing on at random, mingling heterogeneous objects together, and exhibiting them in every variety and perversity of arrangement. Self-government is out of the question, and a wise government can never be introduced without a better understanding of the difficulties under which the child labors. Harsh measures with unbelief never made a Christian, and harsh measures with childhood never made the just proportions of manhood or womanhood. But there is a deeper cause for error yet undisclosed. If the perceptions were rightly adjusted in infancy, childhood would be less at fault. When we recall the fact that sight, which spreads its sensations over extension, presents all objects to the child in wrong positions, we see an adequate cause for error, that must

progressively increase till the sense of touch, by experience in the use of it, may be far enough advanced to gradually rectify the perception of sight. The instinctive eagerness in every child to touch bodies, and the instant satisfaction which follows it, show it to be the correcting faculty of the other perceptions, and the crowning element of intellectual attainment. But there is an extended period over which little else than error must reign, yet painful as the conviction may be, in the end we shall be satisfied with its beneficent design.

STRUCTURE OF THE EYE.

Its differing rates of Motion, and differing spheres of Action from the sense of Touch.

The eye being made chiefly of water, its function and rate of motion are above that of every organ of the body. Its machinery, so delicately organized, is constructed from its own materials.*

The eye is made, and its nerve sent back to meet its commissure, on terms of compromise. The brain admits no vivid sense into its council-chamber, and it sends up a commissure through its own dominions, to offer to the optic nerve, at the threshold

* Acephalous infants have the optic nerves fully organized and sent back to the sella turcica, where they meet no vestige of brain, medulla, or spinal marrow.

of its power, a tract to modify its rate of motion, and this optic tract has a graceful curve, engineered on the same line of base with the nerve itself, but here the courtesy ends; this graceful curve, on its way to the capital, glides off and draws up at the door of the sense of touch, where a conference is held, and the rates of motion defined on equal terms, and then reflected by the medulla into the brain. Of the five senses, only two, sight and touch, spread their sensations over extension, and each of these over a differing extension. There is the most constant relation subsisting between them, and the relation is so uniform, that whatever affects the sight, may affect the touch and the converse.

The vastness of the field over which the faculty of vision gives us a command, together with the precision and permanence of this class of perceptions, leads us to believe that, in spite of the wrong adjustment of the eye, nothing material can escape it. But the presumption that the eye sees whatever is material, fails on a closer inspection. It sees no properties in bodies. Suppose a property, or substance, to be placed at a given distance within the axis of vision, and this property or substance should bear no analogy or resemblance to any other property or substance which had before been embraced by its focal powers, what knowledge could

be gained of its material properties? Little or nothing. Close the eyes, and submit the substance to the sense of touch, and all its essential properties are immediately given.

We forget from habit that our vision here must be always struggling with the infirmity of its primitive adjustment, that if it were now right there would be no room for improvement in our next stage of being, where we are promised to see things as "they are."

In a generalizing excursion, one cannot stop to give particulars of the journey, but as the memory is now coming into play, in connection with the sense of touch, it may be well to localize it in the ganglia of the nervous system. Every perception of the outward world has its memory in the ganglia of its nerves, to send messages to its muscles to obey its will. The eye has the memory of sight in the ganglia of its nerve, the ear retains the memory of the sounds it has heard, the nose the odors which have been spread on its surface, and the tongue recalls the tastes of its past sensations, and each have springs of relation opened by a thought.

In contrast with the animal development, man has five perceptions to open his intercourse with the external world. The sense of touch in the animal is a sensation, and not a perception. In man it is

the perception which rectifies the errors of every perception, by distinguishing properties in bodies which escape the scrutiny of the other senses; and what I desire to present with emphasis here is this, that when the sense of touch has corrected the errors of the other senses, it appropriates the product to itself.

It is said of Piccolomini that she sends a deeper thrill to her audience in the kink of her little finger than by the words which accompany it.

DIGITAL NERVES.

The digital nerves, which constitute the memory of the sense of touch, ascend from the fingers, and are lost in the median, which pursues its direct course to the brachial plexus (ganglion, memory of touch), where the four anterior branches of the lower cervical and first dorsal nerves unite to form the fifth nerve, which passes onward from the GANGLION OF GASSER (memory of touch for the brain), and is traced deep between the transverse fibres of the pons varolii to the lateral tract of the medulla oblongata, immediately behind the olivary

bodies, where the sense of touch was found by Muller's experiments.

From here it is reflected into the brain, where, its testimony already assorted by its analogies, the facts are arranged in the order of their progression for the conclusion of a final judgment.

The judgment being made, this order of arrangement, suggested by the memory of the facts as they stood in the order of their relations, is sent from the ganglion of Gasser into the muscles which give expression to the head, face, and tongue, and through the brachial plexus to the arms. The ganglion of Gasser, the seat of memory for the sense of touch in the brain, reflects all the nerves which give expression to the face and tongue. In its crescentic form it is the daguerreotype of the semilunar ganglion, which receives the reflex action of the vivid senses from the medulla oblongata, through the medium of the spinal marrow.

MEDULLA OBLONGATA.

The medulla is an inch and a quarter long, three-quarters of an inch wide, and half an inch thick. In looking at it as it lay, the passive centre of an axis, resting between the spinal marrow and the brain, it indicated more to the imagination than it

displayed to the senses, and a presentiment of concealment, which had hitherto fascinated and foiled every attempt to disclose it, clothed it with a power of deceptive repose, whose reciprocal relation must be action.

It was this action and reaction which premised it to be a graduating centre for the adjustment of sensation and motion, when suddenly the imagination, in a blaze of emotion, proclaimed it to be the electro-magnet of human life, with its axis and its poles. It is found to reflect all the vivid sensations of animal life, with their highest rate of motion, below into the solar centre, increasing the action of the heart and general circulation, in proportion to the sensations made there; and the degrees of development in these sensations are manifested in the lower limbs in marching, jumping, dancing, and waltzing.

The tense step of the soldier toward the field of his glory is graduated to the highest notes of martial music, and measured to the tap of the muffled drum when the battle tells of the leader that is lost.

While the child is jumping with unmeasured joy, the most graceful cotillion in fashionable life is carried forward by the vivid senses in geometrical progression with the scale of music which guides the motion.

From above, it reflects the motive forces of the intellect to the brain, receiving its testimony as it reflects it through the medium of the collected perceptions of the sense of touch, and while the brachial plexus is filling the arms with mental emotions, GASSER'S GANGLION, with cumulative force of intellectual power, sends its focal expressions to the head, face, and arms, and all acting in unison together, give utterance to the tongue under the guidance of the will.

MENTAL BELIEF.

This dual state of the animal and intellectual relations, seems almost to represent two selfs which are in some respects antagonistic to each other in two forms of belief. The vivid senses obtain a belief by the association of sensations in agreement. If the first inference fails to make a belief, it makes a bias, if the second inference corresponds, the bias is increased, and if the third inference is in agreement, it amounts to a belief, and a conclusion follows which is mistaken for a judgment. No inference, nor any given number of inferences, however they may coincide, can of themselves form a judgment, as the decision by inference is come to before the judgment is reached.

With this distinction in the two processes of ratiocination, it is perceived there are two methods of coming to a conclusion; the one by contingency, where the materials are gathered from the feelings and passions, and where truth may be found by accident; the other by analogy, where belief is founded in a process of reasoning upon facts which form the judgment.

Every human being is disturbed more or less by two forms of belief—the animal and the intellectual. The animal is the solicitor, the intellectual the judge; and he who falls beneath them both has had his mind perverted in childhood, when the intellect was forming,* and he comes to be an object of commiserating sympathy on his way to the grave.

The physico-mental nerve, with its dual relations in maturity, defines the powers of these two forms of belief. In recalling the statement made of this physico-mental nerve, we have found no use for any other nerve to explain the whole phenomena of life. In its reflex action, it exhibits the animal relations below; in its motive force, it gives the intellectual power above. The brachial plexus retains the memory of the sense of touch in the arms, and they are seen lifting up the hands, as

* See p. 102.

witnesses verifying the representations of the brain to their intelligence, fidelity, and care, in assorting and arranging the testimony which the mind, centred in the ganglion of Gasser, is proclaiming from the head, face, and tongue. These are the organs which act in unison in every intellectual process, from the lowest calculation to the highest range of intellectual power, and when they are engaged, the order of silence imposed on the animal relations below, is so profoundly hushed up, that the memory of their existence is closed, leaving man in full command of his powers, and in the full possession of himself.

LIFE, MIND, AND SOUL

These are synonymous terms, and it is impossible to discuss one without involving the other.

It has been shown that the imagination is the furnishing, the will the guiding, the conscience the adjusting, and the judgment the presiding power of the mind.

This construction of the mind's adjustment will be as new to theologians, as the new demonstration of the nervous system is to medical men; and, if this adjustment of mental relations be true, the pilotage of science is as much needed to carry it forward as it was to disclose it.

In discussing the subject, we shall adhere strictly to deductions from the premises of the mind, now laid down, and take up first the

RELATION OF A PART TO THE WHOLE.

This, the darkest problem in science, is the field for the dream-work of the metaphysician and doubts of the sceptic.

The hair splitting discriminations of the one, educated in definite proportions, is lost in definite relations; and the other, contemplating his boundary in definite proportions, perceives no relations out of himself, forgets there is a God: neither of these subjects of discipline comprehend their relations to a whole. The theologian, with his eyes bathed in sorrow and his face set in gloom, points to the imperfections of their nature as the means of their broken relations with God, who is still "reconciling the world unto Himself, through the medium of His only Son." This declaration puts out the light that is in them, by the question which rises—How is it, that God should be reconciling us unto Himself? and the darkness grows visible, when in sorrow and sympathy, He closes by "not imputing their sins unto them."

The ground we now stand on is the grazing

pasture of science. The work of the Saviour in reconciling the world unto Himself was a beneficent design, founded in sorrow, sympathy, and love; and it is left for science to demonstrate the problem of the fall through the medium of the imperfections of our nature.

We were all made good, and if good, better and best, were condensed into one, they would still be farther from perfection than good is from best.

None but he who looks abroad can comprehend the extent of the imperfections of the works of God, and if he cannot see these now, he can have no prevision of what it will be, on that ascending scale of being when good becomes better, and better best. The theologian whose mind and heart are all concentred in the soul of man, believes it to be all there; but it has been shown that all bodies in nature—the earth, the sun, and the solar-system have angles of incidence which are changing relations, and all are moving towards one final end. While these relations are changing, the parts are imperfect, approaching nearer and nearer a standard of adjustment, which proves that matter, like mind, is working its way to a standard, through the medium of the imperfection of its parts.

If the formation of these bodies were based in definite proportions, the parts would be perfect,

and the phenomena of Nature being always the same, a standard must follow beyond which there could be no change. All things being perfect, there could be no after progress, and the central forces in matter must unclose the restraint upon its atoms, and the chaos of confusion before its time, would take the world by surprise.

It follows from this showing in the construction of all things, that it is the imperfection of its parts which maintains the multiplying combination of its atoms in their mutual relations; and we perceive in the order of succession in its developments the cause which our reason approves of the imperfection of all things here below. It has been shown that a substance has parts, and parts are degrees, and degrees are deviations from the standard as well as from each other—the degrees themselves being the difference, the difference is always changing, and therefore contain no *fixed truth* because they contain no reality. Here lies the proof—not that there is no truth, but that no truth is *fixed.* A fixed truth is bounded by its definite proportions to a standard: but a changing truth implies a dismissal of error approaching toward a standard; and this is the natural state of man and of all things which were made for him. But the planets hold an exception in one thing:—in their joyous career of re-

production and growth, unlike man, they will know no decay. When they reach a condition of repose by perfect combination, and can accumulate no more material, attraction gives way, and at this instant of their plenum of force and plenitude of power, in the twinkling of an eye, matter will disappear in the resolution of its own forces, and instantly reappear in its new forms of relation, on a scale of magnitude commensurate with the enlarged capacities of the soul, to enjoy the new sphere of its action in the world of its glory, while the clock of time, like a muffled drum, has been beating seconds to the change of its relations.

PROBLEM OF INTELLIGENCE.

Whatever our standard of intelligence will give us with its experience we must believe, what is above this, must be accepted in faith. The standard of intelligence which is in agreement with its experience, is the element of our belief in agreement with its parts. A safe standard of worldly wisdom of a high order may be set up on this basis, and yet with it, we cannot impart our intellectual sensations to another, whose sensations are not graduated to our own scale of feeling. We may strike a chord above, not hit a level with us,

nor reach a note beneath us. Whatever standard of intelligence we may set up, for our starting point, whether high or low, it is only the deviation from some other standard higher or lower than our own.

In order to understand the nature of that standard; to perceive its joys, its sorrows, its difficulties, its doubts, and its apprehensions of a coming future which its previsions cannot reach, we must assume it. When the Saviour assumed our nature, He parted with His omniscience and His power, and became man, predicated on the assurance that He could call for that omniscience and that power to help him when He needed them.

Assuming our nature was comprehending it, in all its doubts, difficulties, fears and apprehensions; and when He saw that man could never rise above *good*, and deviation from good was moving in sin, His heart, filled with sorrow, shed no smile upon that face from the manger to the cross.

He told His disciples that His Father was in heaven—that He was God, and had given them this world as a specimen of His work, pointing to the sun, moon and stars, as other specimens of His power. He told them that He had sent him, His only Son, to teach them the way to heaven—that He should return there, and that they might be

with him, and in His absence he would comfort them and not forsake them.

At the close of His mission, He parted with His human nature and returned to the kingdom of His Omniscience and glory. This, His death and resurrection, is not a matter of faith; it is the subject of belief in the experience of those who have gone before us—and the belief awaits our choice. If we refuse it, we assume the rein, and the risk, and the responsibility, and the unbeliever casts himself beyond the commiserating sympathy of Him who laid down His life for his salvation.

Is it possible for one to conceive that He who made the atom, the man, the globe, and the solar system, can be defeated by things which He has made? Silence at once the imagination which forged the thought, and expunge its record from the memory, that this history, in its majesty, the most deep, the most profound, the most sacred, the most full of meaning, the most victorious, the most glorious, may remain the focal centre around which all other histories must gravitate in the differing circles of their respective forces through the undefined ages of the histories to come!

It is less difficult to make intelligences than to govern them. If man had started on a higher scale than was given him, he may have been dissatisfied

with the position assigned him in heaven. If remote history be true, the experiment was tried before man was made with the angels themselves. Here disturbing forces, rising from higher starting points of relation, became rebellious and were put down by force. If another platform was to be made, it must be adjusted to a centre where the relations of indulgence to restraint would make a government manageable through the medium of the moral affections; substituting moral restraint for arbitrary power. It is seen that the punishment resulting from the exercise of arbitrary power among the fallen angels to be terrific, while those by moral restraints are softened and enriched by the offers of salvation. For this reason man's starting point was adjusted to the lowest scale of intelligent existence, even in alliance with the animal beneath him, and having this paramount advantage, that he began with the beginning intelligence, and having no chasm left behind, untraversed by his experience, his future is a plane of continued elevation expanding with every step, which must carry him with its radiant light shed by the Saviour's presence, far beyond the scale of angelic existence.

ANALYSIS OF JUSTICE AND MERCY.

Standing in this order of succession, Justice has no antecedent relation, and if the relations of these attributes are misunderstood, the mind is darkened by their counsel. As they now stand, they are not only irreconcilable, but they are in direct antagonism with each other. Justice presiding over mercy draws its lines sternly around itself, is unapproachable and uncompromising, and balances its scales in equal and exact adjustment; while mercy, listening to every feeling, lends itself to every emotion, and metes out its measures, in just proportions to every want. Secondly, Justice looks to the preservation of its own attributes, while Mercy looks to the preservation of its object. Thirdly, Justice loses all by giving any, while Mercy gains by giving.

There is no point of contact, and no agreement in the parts of these attributes, as they are now found together. Wrenched from the order of their succession, they are misplaced, and violate the order of mental construction in all beings which are endowed with intelligence. Reverse them, and they come into harmony with each other in the agree-

ment of their parts. Justice founded in mercy meets its antecedent on equal terms, and in equal and exact adjustment of relations. What can be more merciful than mercy dispensing justice in equal and exact proportion to every want.

There are no fractions left here to make new propositions to correct aberrations. The proposition is true in it self.

The Saviour of the world is represented in the light of a merciful Being, and the Father is misrepresented if placed in antagonism with His Son.

In taking leave of the reader, I wish to apprise him, that with him I perceive the necessity of an immediate revision and amplification of this work; but there is no time for it now. It has been chiefly written within thirty-three days of physical suffering, the pains driving the pen as the spurs of the rider plunged into the sides of his courser goad him onward to his end.

APPENDIX.

RESPIRATION SAVES LIFE BY EXHALING POISON.

Extract from the Annual Address of the Author, delivered before the Academy of Medicine of the State of New York, February 19th, 1851.

The popular theory of respiration on which all calculations of life and health are founded, is, that animal heat is generated by introducing oxygen into the lungs by inspiration; that the process of breathing separates the oxygen of the air from its hydrogen, when the oxygen unites with the blood in the general circulation, and a chemical union of the carbon and oxygen is effected, by which the carbonic acid is expelled from the system through the lungs, and, by means of oxygen thus supplied, animal heat is generated.

This theory is the foundation of the superstructure of life and health. Now, though the teaching of positive truth is the grand means of expelling error, the process is sometimes quickened by the negative argument serving as its pioneer. You will be surprised to learn that no experiments have been spared to confirm this theory, and not one of them has pierced the darkness that mantles its birth.

Negatively considered, if the lungs generated heat by means of respiration, it would seem to imply the power

to increase or diminish the standard of heat by multiplying or withholding the number of respirations per minute. But this is not so—no variableness of breathing alters the temperature of the body, while, on the other hand, every man's experience assures him that he generates heat by motion, and that he is soon compelled to breathe fast to cool himself. But in proof of the position we now take, that breathing is a cooling process, we cite for examples the whole animal world, except the genus homo and the genus horse, and these are not exceptions to the law, only to the rule.

The genus homo and the genus horse have a double privilege of refrigeration, while all other animated beings have but one. You may be surprised to learn that no other beings sweat except men and horses, and hence no other beings can cool themselves, when hot, by perspiration through the skin. The confirmation of this fact is found in the whole range of comparative anatomy, where nature has furnished examples on the most extended scale of magnitude, in the whole animal world, in the largest as well as the smallest of beings.

In all the pachydermata, or thick-skinned animals, except the horse, are found no pores in the skin that exhale heat by perspiration, the envelope on all these animals being only a secreting surface, like others of the internal surface of the body. All the cleft-feet species, including those presenting feet with toes rounded, and unprovided with claws, the elephant, rhinoceros, bison, mammoth, mastodon, buffalo, ox, swine, deer, as well as the lion, tiger, bear, wolf, fox, birds, squirrels, dormouse, opossum, raccoon, all alike offer the same examples as the dog, that they have no other means of cooling themselves when hot except through the medium of the lungs, by respiration.

The farmer drives his oxen, in the summer heat, with

great care, and when they open their mouths and thrust out their tongues, and pant to exhale the heat generated by exercise, if he does not stop their motion, they die with the heat that accumulates within them. His hogs, too, must be driven with more care, and if they are allowed to grow fat in hot weather, they often die, panting, in a state of repose, when in the shade.

All these animals, with the exception of the elephant and rhinoceros, are covered with hair and fur, or feathers and down, which varies with the climate.

The fur and down tribe throw off their rich covering at the approach of spring, and revel with their fellows in a summer's sun, and, as the autumn returns, they are refurnished with their furs and down, in anticipation of the winter's frost.

In health, these animals have a large deposit of fat beneath the skin—fat is a mixture of two or more ingredients, which differ from each other in consistency—in most instances they are stearine and margarine, along with a liquid oleine; as the weather cools these oils and fats condense, and as they solidify they become non-conductors of heat, and as the heat accumulates beneath the skin, it generates the delicate furs and down for winter's use; and in the spring, as the temperature rises, the oleine becomes volatile and sheds them again for the summer's heat: so that this simple law for the generation of heat, in animal as in vegetable life, is graduated by the fluctuations of the season and the revolutions of time. The familiar example of the dog, who generates his heat at the expense of his substance, as he increases his speed, and, having no pores in his skin, he multiplies his respiration in the ratio of motion, as the only means of keeping himself cool, and having no perspiration to check, he plunges into water with impunity, and returns refreshed, when men and horses, submerged in a similar condition,

would suddenly check perspiration, and if they survived the shock, it would be to die with acute or chronic inflammation.

When nature furnishes examples on such an extended scale of operation, for the escape of animal heat, it would seem to deprive the phenomenon of respiration of much of its fictitious value. There are some experiments that have been performed, by introducing foreign bodies into the venous circulation, that are very significant in their results. When mercury is injected into any part of the general venous system, it is invariably found in the lungs, the lungs being the inevitable outlet for all foreign bodies introduced into the general venous circulation. In conclusion we state, that apart from these experiments and the examples of animal life, the only *chemical action* which animal life is known to possess, and the only one which is perfectly known and accurately measured, is the excretion of carbonic acid from the lungs, in the form of watery vapor, which carries off with it the surplus heat as the animal system generates it.

Having stated, as I trust, satisfactorily, that breathing is a cooling process of life, we come next to the consideration of the true and only cause of the generation of heat in man. The analysis of the saliva, gastric juice, chyle and blood, has proved the first process of its formation to be effected by the agency of water; if we now show from whence the water is derived, the chain of testimony will be finished. Liebig has established all the phenomena of the generation of heat acceptably, but overlooking one of its most important facts (the proportion of water in the tissues), he left the mystery as he found it, in its primitive darkness. He had a clear conception of its phenomena, in ignorance of the principle that heat was generated by the oxydation of the tissues; and in the same manner as fire is generated by the de-

composition of the wood it burns up, and that both are governed by the same law; in short, that the body is consumed, wasted and transformed by the generation of heat, precisely as any other ignited substance, and parts with its heat to surrounding matter as that of any other heated mass. That oxygen in both cases combines with the carbon and hydrogen; in both cases the same product is given out, namely, heat, carbonic acid, and the vapor of water; that its generation is rapid in proportion to the loss of substance by exercise, creating a rapid transmutation of the tissues of the body. So that life is a fire, the body its furnace, and the aliments its fuel.

After knowing and saying so much it would seem impossible that so distinguished an author should fall back and seize upon the same errors that were common to his predecessors. If his mind had not been so carefully instructed in the errors of respiration, he would have seen that more oxygen is introduced into the stomach in one minute by a tumbler of pure water, than could be introduced through the medium of the lungs by inspiration (if they could admit it) in several hours.

In ordinary health the average weight of water drunk by a healthy man is about thirty-two ounces per day, while a hard laboring man will often drink from sixty to seventy ounces per day, the quantity being proportioned to the transmutation of the tissues, by the generation of heat and muscular motion.

In every thirty-two ounces of water, the average daily supply of a healthy man, are found twenty-eight ounces and four-ninths of oxygen. Eight ounces of bread is a low average of daily consumption, and this contains two ounces and a half of water, while four-fifths by weight of animal food is water, and if we calculate one pound of this to be the average weight daily consumed, it will yield fourteen ounces and two-ninths of oxygen, which foots up

the account in round numbers to about forty-four ounces of oxygen daily introduced by degrees into the stomach of a healthy man, which is twelve ounces more than the advocates of pulmonary absorption claim to be sufficient to effect the gradual decomposition of all the hydro-carbons and nitrogenized substances that enter the system in the form of food.

Now here is a dilemma. If thirty-two ounces and a half of oxygen were daily introduced into the system through the medium of the lungs, and thirty-two ounces and a half be sufficient to generate animal heat for twenty-four hours, what conceivable force could restrain the spontaneous combustion of the body, if forty-four ounces should get into the system by some other channel, that had been overlooked. Apart from all these plain, simple, and obvious facts, the experiments by the thermometer repudiate this generation of heat in the lungs, as the standard of heat by this instrument ranges from one-half to three-fourths of a degree higher in the stomach than in the lungs. In this central organ combustion begins by the rapid mutation of water, vegetable and animal food, as they are converted into starch, alcohol, lactic acid, and chyme into chyle, wherein every stage of the process from the development of one substance into the next in order, evolves an accumulating force of animal heat. The chyle is then conveyed into the receptaculum chyli, heated a little above the standard heat of the body, and ascends through the thoracic duct, is conducted from thence into the subclavian vein, from thence into the heart, from whence it is driven into the lungs (just as the sap is driven into the leaves of the tree), not for the purpose of being heated, for it returns cooled, but for the purpose of excreting the effete matter immediately derived from crude materials, and is then prepared for the general circulation, when, as it returns, it parts with its

infinitesimal deposits among the various solids of the body, evolving animal heat in the ratio of the conversion of fluid into solid matter.

It is now, I trust, very obvious to my audience how the human system generates its heat. No matter what the temperature of the food may be when taken into the stomach, it is immediately raised to that of the blood. A tumbler of iced water at the temperature of 32° is raised to that of 98° in one-twentieth part of the time that it could be heated to that degree in the blaze of the hottest fire. Now if there was no appointed outlet for this rapid generation of heat, what would become of the animal system? It is plain it could not maintain its standard at 98°, but must run at once into fever and from thence into combustion. In order to maintain its average standard of heat at 98°, there must be a provisionary arrangement for the escape of the accumulating caloric, and this has been proved to be through the channel of the lungs by expiration.

Educated errors enter into permanent combination with the feelings of the mind, and engender prejudices that no exercise of judgment can conquer, and it may be years before this truth, so obvious to the senses, will be accepted by the profession.